VOLUME XXXVI NUMBER 4

# JOURNAL
## OF THE
# ARNOLD ARBORETUM
## HARVARD UNIVERSITY



OCTOBER, 1955




PUBLISHED BY
THE ARNOLD ARBORETUM OF HARVARD UNIVERSITY
CAMBRIDGE, MASS.
1955

# THE JOURNAL OF THE ARNOLD ARBORETUM

Published quarterly by the Arnold Arboretum of Harvard University.

Subscription price $7.00 per year.

Vols. I–XI out of print. Vols. XII (1931), XIII (1932): Price $3.00 each. Vols. XIV (1933)–XXVI (1945): Price $4.00 each. *Note:* Vol. XXVII (1946) number four is out of print; price of nos. 1, 2 and 3 is $2.00. Vol. XXVIII (1947): Price $4.00. Vols. XXIX (1948)–XXXVI (1955): Price $7.00 each.

A limited number of Vol. XXXVI nos. 2 and 3 (the number dedicated to Dr. I. W. Bailey). Price $5.00.

Subscriptions and remittances should be addressed to the ARNOLD ARBORETUM, 22 DIVINITY AVE., CAMBRIDGE, MASSACHUSETTS.

## CONTENTS OF NO. 4



*Vol. XXXVI, Nos. 2 and 3, including pages 119–318, with thirty-two plates, was issued June 7, 1955.*

**Entered as second class matter April 4, 1940, at the post office at Boston, Massachusetts, under the Act of August 24, 1912.**

JOURNAL

OF THE

ARNOLD ARBORETUM

VOL. XXXVI OCTOBER 1955 NUMBER 4

# A MONOGRAPH OF THE GENUS PHILADELPHUS *

SHIU-YING HU

## Series 5. **Delavayani**, ser. nov.

**Philadelphus** subg. II. **Euphiladelphus** sect. 4. **Stenostigma** ser. 5. **Delavayani**, ser. nov.

*Philadelphus* sect. *Stenostigma* subsect. *Satsumani* Koehne in Mitt. Deutsch. Dendr. Ges. **1904** (13): 82. 1904, pro parte.

*Philadelphus* sect. *Poecilostigma* subsect. *Gemmati* Koehne in Mitt. Deutsch. Dendr. Ges. **1906** (15): 51. 1906, pro parte.

TYPE SPECIES: *P. delavayi* L. Henry.

Frutex ramulis griseis, raro castaneis, cortice clauso; foliis ovatis vel ovato-lanceolatis, subtus plerumque dense pubescentibus, inflorescentiis 7-, 9-, raro 5- vel 21-floris; hypanthiis glaberrimis, saepe pruinosis, purpurescentibus; corolla disciformi vel subcampanulata, raro cruciformi; staminibus 25 usque 35, disco et stylo glabris; stigmatibus linearibus, dorsalibus; capsulis obovoideis; seminibus breviter caudatis.

Both geographically and morphologically this series is intermediate between the western Himalayan series Tomentosi and the northern Chinese series Pekinense. Members of this series occur in southwestern China between Long. 98° and 102° E. and Lat. 26° and 30° N. They are characterized by their pubescent leaves, glabrous hypanthia, green and purplish calyx, linear and abaxial stigmata and short-caudate seeds. The distribution of the species in this series is shown in map 5.

### KEY TO THE SPECIES

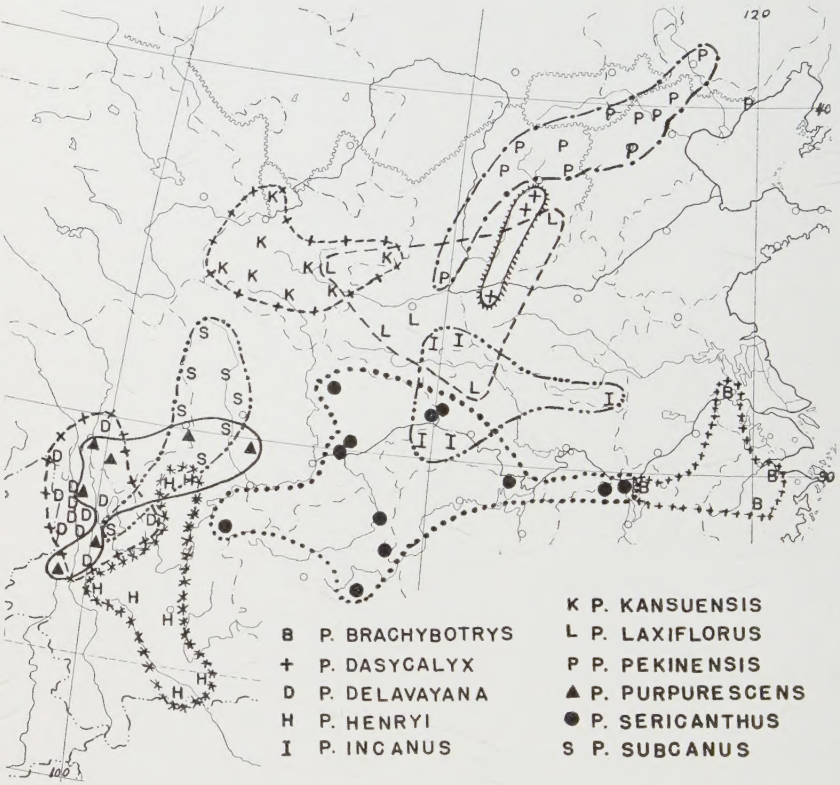
A. Hairs on the lower leaf-surface villose; corolla disciform or rarely cruciform, generally 3 cm. or more in diameter. . . . . 32. *P. delavayi.*

AA. Hairs on the lower leaf-surface strigose; flowers small, the corolla campanulate, less than 3 cm. in diameter. . . . . 33. *P. purpurascens.*

32. **Philadelphus delavayi** L. Henry in Rev. Hort. 1903: 13, *fig. 3.* 1903. — Koehne in Mitt. Deutsch. Dendr. Ges. 1906(15): 51. 1906. —

* *Continued from volume XXXVI, page 109.*

Schneider, Ill. Handb. Laubh. 1: 370. 1905. — Stapf in Bot. Mag. 149: *pl. 9022*. 1924. — Diels in Notes Bot. Gard. Edinb. 7: 106. 1912. — Léveillé, Cat. Pl. Yunnan 255. 1917. — Rehder, Man. Cult. Trees Shrubs 275. 1927; ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1949. — Hand.-Mazz., Symb. Sin. 7: 438. 1931. — Chen, Ill. Man. Chin. Trees Shrubs 372, 1937. — Merr. in Britt. 4: 66. 1941. — Bean in Chitt., Dict. Gard. 3: 1546, *fig.* [1]. 1951.




MAP 5. The distribution of the Chinese species of *Philadelphus*.

TYPE: *J. M. Delavay 2871* (Muséum Nat. Hist. Nat. Paris).

Shrub 2–4 m. high; bark of the second year's growth grayish brown, rarely gray or castaneous, closed, with transverse cracks; current year's growth glabrous, pruinose. Leaves ovate-lanceolate or ovate-oblong, those on the sterile shoot 5–14 cm. long, 2–7 cm. wide, those on the flowering shoot 2–8 cm. long, 2–5 cm. wide, serrate, rarely subentire, rounded or obtuse at the base, acuminate, rarely acute at the apex, the acumen 5–20 mm. long, uniformly setose above, densely villose beneath, the trichomes compressed. Inflorescences 5-, 7-, or 9-flowered, rarely up to 21-flowered,

the lower pairs in the axils of normal leaves, sometimes cymose; pedicels glabrous, 5–10, rarely up to 13 mm. long, hypanthium and calyx glabrous, pruinose, green tinged with reddish brown; sepals ovate, 6 mm. long, 4 mm. wide, acute at the apex; corolla disciform, 2.5–3.5 cm. across, the petals suborbicular, 1–1.5 cm. in diameter; stamens about 35, the longest filament 6 mm. long; disc and style glabrous, the style slightly shorter than the longest stamens, columnar or slightly divided above; stigma linear, the fertile surface generally abaxial, 1.8 mm. long, the adaxial side when fertile shorter and much narrower than the abaxial. Capsules obovoid, 8–10 mm. long, 7 mm. in diameter, the persistent sepals subapical. Seeds short-tailed, the testa castaneous, reticulate and rugose, the tails half as long as the embryo.

CHINA: Southwest Szechuan: Muli, Wachin, Tin-chang, *T. T. Yu 14683* (A). Sikang: Tsarung, Upper Salwin River, *J. F. Rock 22125* (A, NY). Yunnan: Salwin Valley, Sekai, *T. T. Yu 22992* (A); Kiukiang Valley, *T. T. Yu 19461* (A), *21003* (A); Wei-se Hsien, *H. T. Tsai 57954* (A), *59540* (A); Shang-pa Hsien, *H. T. Tsai 54371* (A), *56524* (A), *58749* (A), *58890* (A), *58927* (A); Che-tze-lo, *H. T. Tsai 58456* (A); Likiang, *R. C. Ching 20473* (A), *20718* (A), *20848* (A); same area, *G. Forrest 2195* (A); *J. F. Rock 3340* (A), *11445* (A); *C. W. Wang 71581* (A); Chung-tien, *K. M. Feng 1420* (A); Haba Snow Range, *K. M. Feng 1383* (A); Chien-chuan, *J. F. Rock 8629* (A), *8634* (A, NY); Lan-ping Hsien, *H. T. Tsai 53740* (A); without precise locality, *H. T. Tsai 57172* (A); *T. T. Yu 7085* (A).

TIBET: Latong, *F. Younghusband*, June 29, 1903 (A, G).

UPPER BURMA: Adung Valley, *F. Kingdon Ward 9461* (A).

CULTIVATED: Europe: Hort. Kew, *C. Schneider*, 1902 (A). United States: Arnold Arboretum no. *6597–2*, *A. Rehder*, June 17, 1913 (A) (from Lemoine, with horticultural name recorded by mistake as *Deutzia* 121); Hort. C. S. Sargent, *Veitch-Wilson 1444*, *A. Rehder*, June 12, 1909 (A).

*Philadelphus delavayi* L. Henry is distinguished by its tomentose leaves, purplish-green pruinose glabrous hypanthium and calyx, columnar style with linear stigmata on the abaxial surfaces, obovoid capsules, and very short-tailed seeds. The tomentum on the lower surface of its leaves resembles that of *P. tomentosus* Wall., its short-tailed seeds resemble those of *P. pekinensis* Rupr., and its linear stigma resembles that of *P. sericanthus* Koehne. Geographically it occurs in an area where the Eastern Asiatic and the Himalayan floras mingle, and morphologically it shows the amalgamation of characters peculiar to species of western Himalaya and central and northern China. It is a well-established species and generally occurs at altitudes 700–3800 meters, in open thickets or by streams in wooded valleys. Its white, fragrant flowers appear in June.

Koehne, in 1906, on the evidence of buds exposed on a winter twig collected in February, decided to place this species in the subsection Gemmati. I have observed that the axillary buds of the species of the Gemmati are visible on a sterile or flowering shoot during anthesis. Of all the specimens of *P. delavayi* L. Henry that I have examined there is none which has visible axillary buds during the flowering period. Moreover, each of

the buds in the axils of the fallen leaves on the winter twigs is covered by the abscission layer which bursts open as the enclosed bud unfolds. This character is found only in Euphiladelphus.

In this species the variation in the size of the leaves and the dentation of the margins is great. In general, the leaves are serrate. *Rock 23815* has uniformly small ovate leaves about 1.5–2 cm. long, with faintly denticulate or subentire margins. The large number of branchlets originated from adventitious buds indicates that this specimen was collected from a plant growing under adverse conditions. Variations in the branching or elongation of the pedicels may occur in place of a single flower. For example, *Rock 22125* has cymes on the basal portion of the inflorescences. This tendency to branch, though rare, is not unusual with this species. The photograph published by L. Henry (1903) also illustrates this condition. The pedicels are generally about 1 cm. long. Some fruiting pedicels measure up to 2 cm. long. The calyx in the herbarium specimens of *P. delavayi* L. Henry are all more or less rust-brown in color. Many authors have described the color of the calyx of this species as purplish. But the plant in the Arnold Arboretum has a green calyx.

KEY TO THE VARIETIES

A. The current year's growth of the stem glabrous.
B. Calyx dark purple. ..... a. var. *melanocalyx*.
BB. Calyx green tinged with brown. ..... b. var. *cruciflorus*.
AA. The current year's growth villose. ..... c. var. *trichocladus*.

32a. **Philadelphus delavayi** var. **melanocalyx** Lemoine ex L. Henry in Rev. Hort. **1903**: 14. 1903. — Rehder, Man. Cult. Trees Shrubs 127. 1927. — Chen, Ill. Man. Chin. Trees Shrubs 373. 1937. — Bean, Trees Shrubs ed. 7, **2**: 412. 1950.

*Philadelphus delavayi* sensu Stapf in Bot. Mag. **149**: *pl. 9022*. 1923, non L. Henry.

*Philadelphus delavayi* f. *melanocalyx* (Lemoine) Rehder, Man. Cult. Trees Shrubs ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1949.

LECTOTYPE: Yunnan, *J. F. Rock 4011* (A).

Shrub, the bark of the third year's growth closed, with transverse cracks, tardily wearing off, the second year's growth castaneous, closed, the current year's growth glabrous, striate; leaves ovate-lanceolate, rounded at the base, acuminate at the apex, almost entire, occasionally faintly dentate, uniformly setose above, pubescent on the nerves beneath, 5-nerved; inflorescence 5- up to 9-flowered; hypanthium and calyx glabrous, pruinose, purple; corolla cruciform, 3 cm. across, the petals oblong, 13 mm. long, 9 mm. wide; stamens about 30, the apical third of the style divided.

CHINA: Yunnan: Likiang, *J. F. Rock 4011* (A, LECTOTYPE), *4523* (A); *R. C. Ching 20848* (A); Chung-tien, *K. M. Feng 1420* (A).

The purple calyx variety was first observed by Lemoine de Nancy, who

presented a specimen to Max. Cornu of the Société Nationale d'Horticulture, France. L. Henry published the trinomial but designated no type, hence *Rock 4011* is selected as the lectotype of the variety. Rehder in 1904 treated this taxon as a form. Among the specimens cited above *Rock 4011* and *4523* each has a statement in the field note that the color of the hypanthium and calyx is purplish. These specimens also have ovate-oblong petals which give the corolla a cruciform appearance. The typical *P. delavayi* L. Henry has a green hypanthium and calyx with a brownish tinge, and a discoid corolla with suborbicular petals. The above-mentioned differences are comparable to those that exist between the typical *P. inodorus* Linn. and its varieties. By comparison I think that the varietal rank which L. Henry originally gave to this taxon is better than the status given it by Rehder.

32b. **Philadelphus delavayi** forma **cruciflorus** f. nov.

Frutex, ramulis glaberrimis; foliis ovato-lanceolatis, basi rotundatis vel obtusis, apice acuminatis, serratis vel subintegris; inflorescentiis 7- usque ad 13-floris, floribus solitariis vel cymosis, hypanthiis calycibusque glaberrimis, corolla cruciformi, 4 cm. diametro, petalis oblongis, 2 cm. longis, 8 mm. latis, staminibus ca. 30, disco et stylo glabro, stigmatis linearibus.

CHINA: Yunnan: Wei-si Hsien, *C. W. Wang 63781* (TYPE, A).

The indumentum on the leaves of this variety resembles that of *P. delavayi* L. Henry. It can be readily distinguished from the typical form by its cruciform corolla. The corolla of *P. delavayi* L. Henry is disciform.

32c. **Philadelphus delavayi** var. **trichocladus** Hand.-Mazz., Symb. Sin. 7: 438. 1931.

TYPE: *Genestier 9949* (ISOTYPE, A).

Shrub; bark of the second year's growth castaneous or grayish brown, closed; of the current year's growth crispulo-villose; leaves ovate or ovate-elliptic, acute or rounded at the base, acute or acuminate at the apex, uniformly setose above, the hairs compressed, densely tomentose or velvate beneath, subentire or denticulate; inflorescences 5- up to 12-flowered; hypanthia and calyx glabrous; corolla disciform, 3–4 cm. across, the petals ovate-suborbicular, 1.3–2 cm. long, 9–15 mm. wide.

SOUTHEAST TIBET: (Sikang): *G. Forrest 19133* (PARATYPE).
CHINA: Yunnan: Tschamutong, *P. Genestier 9949* (ISOTYPE, A); Atung-tze, Pei-ma-shan, *J. F. Rock 22755* (A, NY); Tse-chung, *T. T. Yu 19006* (A); without precise locality, *G. Forrest 16211* (A), *16412* (A); *T. T. Yu 6618* (A), *8438* (A).

*T. T. Yu 19006* represents an abnormal form. The indumentum on the stems and leaves is extraordinarily thick, the inflorescence tends to be subpaniculate, and some stigmata are bifid.

33. **Philadelphus purpurascens** (Koehne) Rehder in Mitt. Deutsch. Dendr. Ges. **1915**(24): 220. 1916.

*Philadelphus brachybotrys* var. *purpurascens* Koehne in Sargent, Pl. Wils. **1**: 6. 1911.

*Philadelphus delavayi* sensu Hutchin. in Bot. Mag. **136**: *pl. 8324*. 1910, non L. Henry.

*Philadelphus nepalensis* sensu Diels in Notes Bot. Gard. Edinb. **7**: 291. 1912. — sensu Lévl., Cat. Pl. Yunnan 225. 1917, non Koehne.

*Philadelphus delavayi* var. *calvescens* Rehder in Jour. Arnold Arb. **1**: 196. 1919, **5**: 236. 1924; Man. Cult. Trees Shrubs 275. 1927; ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1949. — Hand.-Mazz., Symb. Sin. **7**: 438. 1931. — Chen, Ill. Man. Chin. Trees Shrubs 372. 1937.

*Philadelphus henryi* var. *lissocalyx* Hand.-Mazz., Symb. Sin. **7**: 438. 1931.

LECTOTYPE: Ta-chien-lu, *E. H. Wilson 1346* (A).

Shrub 2–4 m. high; bark of the second year's growth brown, grayish or castaneous, closed, the current year's growth glabrous. Leaves ovate or ovate-lanceolate, those on the sterile branchlets 3.5–8 (rarely up to 11) cm. long, 1.5–4 (rarely up to 6) cm. wide, those on the flowering branch 1.5–6 cm. long, 0.5–3 cm. wide, usually uniformly strigose above, sometimes only the apical half sparsely strigose above, strigose on the nerves beneath, serrate. Inflorescence 5- up to 9-flowered, rarely in weak branches 1- or 3-flowered; hypanthium and calyx glabrous, green tinged with purple, slightly glaucous; sepals ovate, 4–6 mm. long, 3–4 mm. wide; corolla campanulate, 3 rarely up to 4 cm. across, the petals oblong, 1.5–2 cm. long, 9–15 mm. wide; stamens 25 up to 30, the longest 8 mm. long, style and disc glabrous, the style 5 mm. long, the stigmas linear, 1.8 mm. long, abaxial. Capsules obovoid, 7 mm. long, 5 mm. in diameter, the persistent sepals apical. Seeds short-tailed, the tail half as long as the embryo, testa castaneous, reticulate and rugose.

CHINA: Sikang (formerly called Western or Southwestern Szechuan): West of Ta-chien-lu (Kanting), *E. H. Wilson 1346* (LECTOTYPE, A); Ta-p'ao-shan, NE of Ta-chien-lu, *E. H. Wilson 3046* (A); ascending Fu-pien Hsien, *F. T. Wang 21368* (A); Muli, mountains of Kulu, *J. F. Rock 18024* (A); Mount Kongka, *J. F. Rock 16284* (A, NY), *16673* (NY), *16492* (NY); Mt. Siga, *J. F. Rock 23815* (A, NY), *24380* (A, NY); between Litang and Yalung Rivers, *J. F. Rock 16673* (A); Tsa-wa-rung, *C. W. Wang 65583* (A). Yunnan: Atungtze, *C. W. Wang 69834* (A), *70020* (A); *T. T. Yu 10589* (A); northeast of Likiang, Tzaikoo Snow Range, *R. C. Ching 21274* (A); west of Likiang, Tamichung, *R. C. Ching 21463* (A); west of Likiang, *R. C. Ching 21876* (A); northwest of Likiang, I-chi, *R. C. Ching 21938* (A); Likiang Snow Range, *R. C. Ching 30185* (A), *30294* (A); same region, *K. M. Feng 3028* (A); *J. F. Rock 4091* (A), *3386* (A), *4522* (A, NY), *3547* (A), *11416* (A), *24846* (A, NY); *C. Schneider 1806* (A); 1896 (TYPE of *P. delavayi* var. *calvescens Rehder*, A); *C. W. Wang 70650* (A), *70744* (A), *70847* (A), *70973* (A), *71158* (A); *T. T. Yu 15066* (A); Haba Snow Range, *K. M. Feng 1091* (A); Tali (Dali), *Handel-Mazzetti 8696* (ISOTYPE of *P. henryi* var. *lissocalyx* Hand.-Mazz., A); Tali Range, *G. Forrest 5036* (A); west of Tali, *J. F. Rock 6813* (A), *C. W. Wang 63165* (A); Chung-

tien, *K. M. Feng 1012* (A), *3300* (A); *T. T. Yu 13869* (A); Kouty, *Siméon Tén 469* (A), *543* (A); without precise locality, *H. T. Tsai 57597* (A); *T. T. Yu 11316* (A).

CULTIVATED: England: Hort. Veitch, *1768*, *E. H. Wilson*, 1911. United States: Arnold Arboretum *6599–1* (Plant *Veitch 1768W*); *6599–2 = 15413* (Veitch *1778a*), *E. H. Wilson*, June 17, 1913 (A); Golden Gate Park, *E. Walther*, May 8, 1932 (A).

This species was first described as *P. brachybotrys* Koehne var. *purpurascens* Koehne on the basis of two specimens collected by E. H. Wilson from western Szechuan (now known as Sikang). No taxonomical type was designated. *Wilson 1346* has both flower and fruit, and it is here selected as a lectotype.

*Philadelphus purpurascens* (Koehne) Rehder was introduced into cultivation by E. H. Wilson. The specimens in the Arnold Arboretum indicate that his seed no. *1768W* germinated in 1911 in Hort. Veitch and no. *1778a* germinated in the same garden in 1913. Number *1768W* is associated with Wilson's herbarium specimen no. *1346*. In the Arnold Arboretum it is numbered *6599–1*.

In 1925 seeds were collected from this plant and germinated by W. H. Judd. *Veitch 1778a* was also introduced in the Arnold Arboretum and is cultivated under the number *15413 = 6599–2*. The specimen is rather sick-looking. The calyx is yellowish green with some brownish tinge. It does not appear to be a very ornamental species.

33a. **Philadelphus purpurascens** (Koehne) Rehder var. **venustus** (Koehne), comb. nov.

*Philadelphus venustus* Koehne in Mitt. Deutsch. Dendr. Ges. **1906:** 53. 1906; et in Fedde Repert. Sp. Nov. **6:** 335. 1909.

LECTOTYPE: Hort. Vilmorin *3501, C. Schneider*, June 2, 1906 (A).

Shrub 2–3 m. high; bark of the second year's growth close, gray or brown, the current year's growth uniformly villose; leaves ovate, those on the flowering shoot 1.5–4.5 cm. long, 0.5–2 cm. wide, acute or rounded at the base, acuminate at the apex, uniformly strigose above, the hairs compressed and appressed, strigose on the nerves beneath; inflorescences 5- or 7-flowered; pedicels 3–10 cm. long, glabrous; hypanthium and calyx glabrous; corolla subcampanulate, the petals suborbicular-oblong, 1–1.3 cm. long, 1 cm. wide; disc and style glabrous; stigma linear, 1 mm. long, abaxial.

CHINA: Southwestern Szechuan: Muli, mountains of Kulu, East of Muli Gomba, *J. F. Rock 16492* (A); between Hunka and Waloho, *C. Schneider 1529* (A). Yunnan: Sungkwei Range, *G. Forrest 23069* (A); without precise locality, *T. T. Yu 6000* (A), *6053* (A).

CULTIVATED: Hort. M. L. de Vilmorin, *Les Barres 3501, C. Schneider*, June 2, 1906 (A, probably a specimen from the type plant).

This variety occurs at altitudes of 3650–4425 meters in southwestern Szechuan and adjacent Yunnan.

Koehne described *P. brachybotrys* var. *purpurascens* on the basis of two specimens collected by Wilson. One of these was collected west of Ta-chien-lu and the other from Ta-p'ao-shan, northeast of Ta-chien-lu. According to Koehne *P. venustus* was raised from seeds sent to Vilmorin by a French missionary, Soulié, who was stationed in E. Tibet. We know that Soulié was stationed at Tongolo, a village about twenty-five miles west of Ta-chien-lu. Geographically *P. venustus* Koehne and *P. purpurascens* (Koehne) Rehder are from the same area. Morphologically they differ only in the presence or absence of hair on the current year's growth. *Philadelphus purpurascens* (Koehne) Rehder is a better known taxon in the botanical literature, and as represented by the Arnold Arboretum collections, it also has a wider range than Koehne's *P. venustus*, which I consider a pubescent variety.

Series 6. **Pubescentes,** ser. nov.

**Philadelphus** subg. II. **Euphiladelphus** sect. 4. **Stenostigma** ser. 6. **Pubescentes,** ser. nov.

*Philadelphus* sect. *Stenostigma* subsect. *Gordoniani* Koehne in Gartenfl. **45:** 450, 542. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904** (13): 81. 1904, pro parte.

*Philadelphus Coronarii* Rydb. in N. Am. Fl. **22:** 162. 1905, in clavi, s. stat.

*Philadelphus* ser. *Gordoniani* (Koehne) Rehder, Man. Cult. Trees Shrubs ed. 2, 207. 1940; et Bibl. Cult. Trees Shrubs 191. 1949, pro parte.

TYPE SPECIES: *P. pubescens* Loisel.

Frutices grandes, ramulis cinereis, bienniis cortice clauso, hornotinis glabris; foliis ovatis vel ovato-ellipticis, supra praeter nervos primarios glabris, subtus dense strigoso-villosis; inflorescentiis 7-, 9-, raro 5- vel 11-floris; hypanthiis calycibusque pubescentibus; capsulis obovoideis; seminibus medie caudatis.

The center of distribution of the species of this series, as shown in map 3, is the Nashville Basin. The range extends northward to Pope County in Illinois and southwestward to the Ozark Plateau and the Ouachita Mountains. Species of this series are characterized by very pubescent leaves, hypanthia and calyces, and by medium-caudate, relatively large seeds. These characters suggest that the closest relationship is with the Chinese series Sericanthi, especially the species that occur in the peneplains of northwestern Hupei, eastern Szechuan and Kweichow.

KEY TO THE SPECIES

A. Style and disk glabrous; base of the corolla glabrous. . . . . 34. *P. pubescens.*
AA. Style and disk pubescent; base of the corolla pubescent on the outside. . . . . 35. *P. gattingeri.*

34. **Philadelphus pubescens** Loiseleur, Herb. Gén. Amat. **4:** *pl. 268.* 1820. — Drapiez, Herb. Amat. Fl. **6:** *pl. 440.* 1833. — Koehne in

Gartenfl. **45**: 542. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904**(13): 81. 1904. — Schneider, Dendr. Winterst. 186. 1903; et Ill. Handb. Laubh. **1**: 369, *fig. 235, f–m.* 1905. — Apgar, Orn. Shrubs U. S. 197, *fig. 310.* 1910. — Moore in Bailey, Stand. Cycl. Hort. **5**: 2581. 1916. — Trelease, Wint. Bot. 74. 1918. — Starcs, [Handb. Trees Shrubs Latvia] 158. 1925. — Rehder, Man. Cult. Trees Shrubs 273. 1927; ed. 2, 267. 1940; et Bibl. Cult. Trees Shrubs 191. 1949. — Bean, Trees Shrubs ed. 7, **2**: 418. 1950. — Fernald, Gray's Man. ed. 8, 747. 1950. — Gleason, Ill. Fl. **2**: 273. 1952.

*Philadelphus grandiflorus* sensu Ker in Bot. Reg. **7**: *pl. 570.* 1821. — sensu P. W. Watson, Dendr. Brit. **1**: *pl. 46.* 1824. — sensu Walp., Repert. **2**: 151. 1843, pro parte, non Willd.

*Philadelphus latifolius* Schrader ex DC., Prodr. **3**: 206. 1828; et in Linnaea **12**: 394. 1838. — Louden, Arb. Frut. Brit. **2**: 953, *fig. 676.* 1838. — Schneider, Ill. Handb. Laubh. **1**: 369, *fig. 237, i–l.* 1905. — Rydb. in N. Am. Fl. **22**: 168. 1905. — Syereishtchikof (Suiereishchikow), Ill. Fl. Mosc. **2**: 221, *fig.* [2]. 1907. — Beadle in Small, Fl. 507. 1903; ed. 2, 507. 1913; et in Small, Man. South. Fl. 599. 1953. — Starcs, [Handb. Trees Shrubs Latvia] 159. 1925.

*Philadelphus discolor* Rafin., Autikon Bot. 149. 1840. — Merr., Ind. Rafin. 135. 1949.

*Philadelphus grandiflorus* var. *floribunda* Gray, Fl. N. Am. **1**: 595. 1840.

*Philadelphus latifolius* var. *pubescens* Dippel, Handb. Laubh. **3**: 339. 1893.

*Philadelphus dubius* hort. ex Koch, Dendr. **1**: 343. 1896.

TYPE: *M. Fraser.*

A stiff, tall shrub up to 5 m. high, the branches cinereous, the second year's growth 3–4 mm. across, the bark closed, with few transverse cracks, the current year's growth glabrous. Leaves ovate or broad-ovate, those on the vegetative shoots 4–8 (rarely to 15) cm. long, 3.5–6.5 (rarely to 10.5) cm. wide, those on the flowering shoots 4–8 cm. long, 3–5.5 cm. wide, rounded at the base, abruptly short-acuminate at the apex, the acumen 3–10 (rarely to 20) mm. long, remotely denticulate or subentire, glabrous with the principal nerves sparsely scabrid-pilose above, uniformly strigose-villose beneath. Inflorescences 7-, 9-, rarely 5- or 11-flowered, the lower pairs in the axils of normal leaves; pedicels, hypanthium and sepals uniformly strigose-villose, the sepals ovate, 6–7 mm. long, the apex acuminate; corolla cruciform, 3.5 cm. across, the petals obovate-oblong, 12–15 mm. long, 10–12 mm. wide; stamens ca. 37, the longest 9 mm. long; disc and style glabrous, the stigmata oar-shaped, the adaxial and abaxial stigmatic surfaces about the same length. Capsules obconic, 7–9 mm. long, 5 mm. in diameter, the persistent calyx subapical. Seeds rather large, the embryos ellipsoid, 2 mm. long, 0.75 mm. in diameter, the tail 1.5 mm. long, the lobes of the crown pointed.

UNITED STATES: **Illinois:** Pope Co., Golconda, *E. J. Palmer 19581* (A, F, G, MO), *22582* (A, F, MO). **Tennessee:** Cheatham Co., Kingston Spring, *H. Eggert*, Aug. 19, 1897 (MO, NY); Davison Co., Nashville, *T. G. Harbison 63*

(A), *E. B. Harger 7808* (G, TENN); *A. Gattinger 838* (F 205899C, F 309472A); Montgomery Co., Clarksville, *E. J. Palmer 17625* (A, F), *17629* (MO). **Arkansas:** Faulkner Co., Hardinville, *E. J. Palmer 26539* (A); Garland Co., Gulpha Creek, *E. J. Palmer 24950* (A); Logan Co., Magazine Mountain, *E. J. Palmer 23228* (A, G, MO, US); Newton Co., Jasper, *E. J. Palmer 6934* (A, F, US), *27087* (A, MO); Van Buren Co., *G. M. Brown*, June 9, 1909 (A), May 8, 1910 (A). **Oklahoma:** Le Flore Co., Rich Mountain, *E. J. Palmer 20623* (A, US); *F. A. Merk*, Oct. 20, 1935 (MO).

CULTIVATED: Europe: Kew, *Macklearn 453* (BH), *G. Nicholson 1609* (A); Hort. Vilmorin, 1928 (A); Hort. Plantières, *C. Schneider*, Sept. 13, 1903 (A), June 25, 26, 1906 (A); Hort. Bot. Berol., *E. Koehne 11* (MO); Breslau, Gopperthain, *C. Baenitz*, June 16, 1905 (BH, US), July 1, 1902 (F), June 11, 1907 (BH, US); Hort. Götting, *A. Rehder 396* (A), *1662* (A), *1637* (A, MO); Bot. Gart. Forstakadamie Hannover *56*, *H. Zabel* (A); Hort. Bot. Petropolitano (A); Hort. Bot. Leipzig, *C. K. Schneider*, June 25, 1904 (A); Hort. Späth, *C. K. Schneider* in 1902 (A); Les Barres, *C. Schneider*, June 6, 1906 (A). Canada: Ottawa, Central Exper. Farm, *R. A. Inglis*, July 6, 1916 (BH); Dominion Arboretum *X–2–148*, *J. M. Gillett 185* (BH). United States: Arnold Arboretum *543–3*, *G. M. M.*, June 22, 1923 (BH), 1059–36, *R. B. Clark*, June 13, 1941 (BH), *2221*, without collector, June 28, 1888 (A); *226–1*, *W. H. Manning* in 1892 (BH), *6840*, without collector, June 30, 1913 (A), Sept. 10, 1913 (A), *2213–1*, without collector, June 20, 1904 (A), June 27, 1904 (A); Ithaca, Herb. Bailey, June 25, 1925 (BH), Sept. 10, 1928 (BH); Highland Park, Rochester, *R. E. Horsey*, Sept. 4, 1918 (BH); Kansas State Agr. College, *E. A. Papenoe*, June 7, 1901 (US); St. Louis, *E. E. Sherff*, July 13, 1910 (F); Garden of Anson & Anita Blake, Cal., *N. F. Bracelin 2728* (BH); Pine, Indiana, *C. W. Duesner*, 1908 (F). Australia: Roy. Hort. Soc. Garden, Wisley, Surrey, June 1933 (BH).

*Philadelphus pubescens* was validated by the publication of a colored plate and a careful description of a five-year-old plant cultivated in the garden of M. Noisette, who got it from Fraser, a British botanical explorer. G. M. Brown's collection from Arkansas matches Loiseleur's illustration the best, and the identification of the specimens cited above is done by comparing them with that collection.

Schrader in 1828 and 1838 characterized *P. latifolius* Schrader as a plant with broad-ovate, long-acuminate leaves. He recognized *P. latifolius* hort. and *P. pubescens* hort. as conspecific and stated that the plant was a native of North America. He overlooked Loiseleur's earlier valid publication of the specific name and chose *P. latifolius* instead of *P. pubescens*. Thus his choice becomes a synonym of the latter binomial.

According to Rafinesque's description, *P. discolor* has glabrous branchlets, broad-ovate or subcordate leaves glabrous above, white-pilose beneath, and terminal subracemose flowers. This is a very good description of *P. pubescens* Loisel.

*Philadelphus pubescens* Loisel. is the most commonly cultivated species. Many names have been used in the trade or gardens. Among the specimens received by the Arnold Arboretum are plants named *P. cordifolius* (Vilmorin), *P. gordonianus* (Kansas, Späth), *P. grandiflorus* (Kew), *P. globosus* (Plantières), *P. inodorus* var. *grandiflorus* (Kew), *P. incanus* (Can-

ada), *P. nivalis* (Plantières), *P. insignis* (Les Barres), *P. verrucosus* (many), *P. zeyheri* (Germany), and several other unpublished binomials. The lack of discrimination in naming the species in botanical gardens may have been the cause of some undue statements in the conclusions of cytologists.

34a. **Philadelphus pubescens** var. **verrucosus** (Schrader), comb. nov.

*Philadelphus verrucosus* Schrader ex DC., Prodr. **3**: 205. 1828; et in Linnaea **12**: 40. 1838. — Loudon, Arb. Frut. **3**: 952, *fig. 675*. 1838. — Lavallée, Arb. Segrez. Enum. 115. 1877. — Rehder in Jour. Arnold Arb. **2**: 154. 1921; Man. Cult. Trees Shrubs 273. 1927; ed. 2, 267. 1940; et Bibl. Cult. Trees Shrubs 191. 1949.

*Philadelphus rhombifolius* Rehder in Jour. Arnold Arb. **1**: 195. 1920. — Nemato. Nippon Shok. Sor. Hoi 294 (Fl. Jap. Suppl.). 1936.

TYPE: Conservatoire et Jardin botaniques, Genève, *Schrader* 1827.

A tall erect shrub, the branches gray, the current year's growth glabrous; leaves elliptic, ovate-elliptic or oblong-elliptic, those on the vegetative shoot 6.5–15 cm. long, 4–9 cm. wide, those on the flowering shoot 3.5–10 cm. long, 1.5–5 cm. wide, acute or obtuse at the base, abruptly short-acuminate at the apex, subentire or remotely serrate or dentate, glabrous above, uniformly strigose-villose beneath, inflorescences 7-, 9-, or 5-flowered.

UNITED STATES: **Illinois:** Pope Co., Golconda, *E. J. Palmer 15438* (A, MO), *23021* (A), *23773* (A, MO). **Missouri:** McDonald Co., Southwest City, *J. A. Steyermark 5573* (F, MO), *65196* (F). **Tennessee:** Cheatham Co., Pegram, *H. K. Svenson 10297* (G, MO, TENN); Biltmore Herb. *5836* (A, G, MO, NY, US), *5836a* (G); *E. P. Bicknell*, May 14, 1894 (NY); *L. G. Charlesworth 3717* (TENN); *A. Gattinger 838* (G, MO, NY, TENN); Montgomery Co., *A. & E. Clebsch*, May 18, 1946 (TENN). **Arkansas:** Independence Co., Batesville, *D. Demaree 17058A* (NY); Hempstead Co., *J. M. Greenman 4416* (MO); *E. J. Palmer 24028* (A, US), *24997* (A); Garland Co., *E. J. Palmer 29155* (A); Hot Spring Co., *E. J. Palmer 29713* (A); Logan Co., *E. J. Palmer 24153* (A); Van Buren Co., *G. M. Brown*, May 8, 1910 (A). **Oklahoma:** Le Flore Co., Rich Mountain, *E. J. Palmer 22249* (A).

CULTIVATED: Europe: Kew, *G. Nicholson 1583* (A); Bot. Gart. Forstakadamie Hannover, *4. H. Zabel*, June 30, 1873 (A), Sept. 1, 1873 (A). Asia: Japan: Prov. Musasi, without collector, June 30, 1910 (TYPE of *P. rhombifolius* Rehder). Canada: Ottawa, Dominion Arboretum *X–2–150, J. M. Gillett 179* (BH), *X–2–172, J. M. Gillett*, July 3, 1939 (BH); *96–147–38, J. M. Gillett*, July 3, 1939 (BH). United States: Arnold Arboretum *542–1, W. H. Manning* in 1892 (BH), *2214–1 = 15375, A. Rehder*, July 18, 1918 (A), June 19, 1919 (A), July 9, 1920 (A); *2214–3 = 15376, A. Rehder*, June 20, 1920 (A); Ithaca, Herb. Bailey, June 28, 1916 (BH); Cherokee Park, Louisville, *M. Slack*, 1939 (BH); Missouri Bot. Gard., *H. Kellogg*, May 1902 (US).

Most modern authors interpret *P. verrucosus* Schrader as a synonym of *P. pubescens* Loisel. Rehder re-established Schrader's species on the basis of Palmer's discovery on the rocky bluffs of the Ohio River in Golconda, Illinois. He claimed that the stem of this species is exfoliate. Palmer col-

lected several numbers in that locality. None of the second year's growth has exfoliate bark. *Palmer 15438* has some third year's growth of which the bark has partially worn off.

When Schrader published *P. verrucosus* he compared it with *P. pubescens* Loisel. ( = *P. latifolius* Schrader). He distinguished them by their leaf forms. Schrader's type is very fragmentary. His plate clearly depicts a plant with elliptic or ovate-elliptic leaves acute or obtuse at the base. In the spontaneous flora of southeastern United States this form exists side by side with the typical *P. pubescens* Loisel., which has ovate leaves rounded at the base. The nature and density of the indumentum of this elliptic-leaved form resembles that of *P. pubescens*. I think it deserves no higher rank than that of variety.

The type of *P. rhombifolius* Rehder is not a Japanese *Philadelphus*. A plant with long strigose-villose pubescent hypanthia, sepals, and leaves is not known in the spontaneous Japanese flora. It matches *P. pubescens* Loisel. very well and must have come from cultivated material.

35. **Philadelphus gattingeri**, sp. nov.

Frutex grandis, ramis cinereis, bienniis 3 mm. diametro, cortice clauso, hornotinis glabris, nodis eciliatis: foliis ovatis vel ovato-oblongis, 3–6.5 cm. longis, 1.5–3.2 cm. latis, basi rotundatis, raro obtusis, apice acutis, raro breviter acuminatis, integris, raro utrinque 1 vel 2 dentibus inconspicuis, supra glabris, ad nervos strigoso-pilosis, subtus uniforme strigoso-villosis, pilis incanis, basi curvatis; inflorescentiis 9- raro 5-floribus, paribus inferioribus in axillis foliorum positis; pedicellis, hypanthiis et calycibus strigoso-villosis, pilis incanis, sepalis ovatis 5 mm. longis, 3–4 mm. latis, apice acutis; corolla disciformi, 3 cm. diametro, petalis obovatis, 1.3 cm. longis, 1.2 mm. latis, apice rotundatis, basi dorsis pilosis; staminibus ca. 35; disco et stylo pilosis, stigmatibus spatulatis.

UNITED STATES: **Tennessee:** Bluffs of Cumberland River near Nashville, *A. Gattinger 838* (US *1119570*, TYPE; F *205899B*, F *309472B*, MO *775002*, NY, US *25563*, US *772375*, ISOTYPES).

*Gattinger 838* involves three different elements, *P. hirsutus* Nutt., *P. pubescens* Loisel., and the type material of *P. gattingeri*. In order to distinguish this material from specimens pertaining to the other two species, the accession numbers of the herbaria where the type and isotypes are deposited are also given. This species is closely related to *P. pubescens* Loisel., from which it can be distinguished readily by its pubescent style.

Series 7. **Sericanthi** Rehder

**Philadelphus** subg. II. **Euphiladelphus** sect. 4. **Stenostigma** ser. 7. **Sericanthi** Rehder in Jour. Arnold Arb. 1: 196. 1920; Man. Cult. Trees Shrubs ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1949.

*Philadelphus* sect. *Stenostigma* subsect. *Satsumani* Koehne in Gartenfl. **45**:

450, 561. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904** (13): 82, 84. 1904, pro parte.

TYPE SPECIES: *P. sericanthus* Koehne.

Shrubs of medium height, the branches gray, the second year's growth brown, castaneous or gray, the bark moderately exfoliate or closed and slowly wearing off; leaves ovate or ovate-elliptic, pubescent, at least on the primary nerves beneath; inflorescence racemose, rarely paniculate, 7-, 9-, rarely 15- or 3-flowered; hypanthia more or less pubescent; capsules obovoid or obconic; seed short- or medium-caudate.

This series contains a heterogeneous group of the Chinese species of *Philadelphus* which have more or less pubescent hypanthia. The density and the type of the hairs on the hypanthia vary considerably. In some species, such as *P. incanus* and *P. reevesianus*, the epidermal tissue of the hypanthium is completely obscured by the white strigose hairs, and in other species, as *P. tenuifolius*, the epidermal tissue of the hypanthium is largely exposed and the hairs are very sparse, often only present at the basal portion of the hypanthium. Phytogeographically, species of this series are concentrated on the Tsinling Range, from the western end of which the distribution extends in accordance with the north-south Sino-Tibetan Mountains southward to Yunnan and northward to Kansu. From the eastern end of the Tsinling Range the distribution extends southward, reaching the Kweichow Plateau and the northern section of Kiangsi. It is interesting to point out that the species that occur in this eastern area are morphologically very similar to species of the Ozark Plateau. The species that occur in the southeastern highlands of Manchuria are comparatively more remotely related to the West China members of this series. The distribution of the species of this series is shown in maps 5 and 7.

KEY TO THE SPECIES

A. Hypanthia densely covered by white hair, the tissue beneath obscured.
  B. Style and disc glabrous.
    C. Hairs on the hypanthia strigose, appressed; leaves pubescent.
      D. Anthers glabrous ..... 36. *P. incanus*.
      DD. Anthers setose ..... 37. *P. reevesianus*.
    CC. Hairs on the hypanthia villose and erect; leaves glabrous (except some cultivated forms). ..... 38. *P. dasycalyx*.
  BB. Rim of disc setose; hair on the hypanthia long-villose, erect. ..... 39. *P. mitsai*.
AA. Hypanthia sparsely covered, the tissue beneath visible.
  B. Disc and style glabrous.
    C. Hypanthia and sepals uniformly covered.
      D. Leaves on the flowering branches serrate; hairs on the hypanthia strigose. ..... 40. *P. sericanthus*.
      DD. Leaves on the flowering branches entire or faintly denticulate; hair on the hypanthia scabrid. ..... 41. *P. henryi*.
    CC. Hypanthia partially covered, the hairs usually occurring at the base, sepals usually glabrous. ..... 42. *P. tenuifolius*.
  BB. Disc, style, or both pubescent.

C. Hair on the hypanthia golden and crisp, appressed, or villose-sublanate.
D. Leaves uniformly pubescent beneath; style and disc crisp villose. ..... 43. *P. subcanus.*
DD. Leaves almost glabrous, strigose only on the primary nerves beneath; style glabrous, rim of disc setose. ..... 44. *P. kansuensis.*
CC. Hair on the hypanthia straight, pilose, or strigose.
D. Leaves ovate, rarely ovate-elliptic, subentire or denticulate; style half or more divided, the stigmata clavate; hypanthia pilose, the sepals glabrous. ..... 45. *P. schrenkii.*
DD. Leaves elliptic, prominently sharp-serrate; style undivided, the stigmata spatulate; hypanthia strigose, the hair incanous. ..... 46. *P. hupehensis.*

36. **Philadelphus incanus** Koehne in Gartenfl. **45**: 562. 1896, exclud. specim. *Henry 8823*; in Mitt. Deutsch. Dendr. Ges. **1904**(13): 84. 1904; in Sargent, Pl. Wils. **1**: 5. 1911 et **1**: 145. 1912. — Schneider, Ill. Handb. Laubh. **1**: 370. 1905. — Diels in Bot. Jahrb. **29**: 371. 1900. — Smith in Jour. Linn. Soc. Bot. **36**: 500. 1905. — Wilson, Arnold Arb. Exp. China 1910–11, *pl. 27*. 1912. — Bean, Trees Shrubs **2**: 135. 1914; ed. 7, **2**: 414. 1950; et in Chitt., Dict. Gard. **3**: 1546. 1951. — Hers in Jour. N. China Branch Roy. As. Soc. **53**: 113. 1922; et List. Ess. Lign. Honan. 20. 1922. — Rehder in Jour. Arnold Arb. **5**: 153. 1924; Man. Cult. Trees Shrubs 274. 1927; ed. 2, 268. 1940; et Bibl. Cult. Trees Shrubs 192. 1949. — Chen, Ill. Man. Chin. Trees Shrubs 371, *fig. 278*. 1937.

*Philadelphus coronarius* var. *tomentosus* sensu Forbes & Hemsl. in Jour. Linn. Soc. Bot. **23**: 277 (Ind. Fl. Sin. I). 1887, non Hook. f. & Thoms.

LECTOTYPE: *A. Henry 6093* (A).

A stiff erect shrub 1.5–3.5 m. high; the second year's growth gray, closed, or brown, tardily exfoliating; current year's growth villose. Leaves ovate, elliptic, or rarely elliptic-lanceolate, 4–8.5 cm. long, (1–) 2–4 cm. wide, those of the vegetative shoots up to 10 cm. long, 6 cm. wide, sparsely setose above, the hairs erect, uniformly strigose-villose beneath, the hairs appressed, serrate. Inflorescence 7- or 11-flowered, the lower pairs usually in the axils of normal leaves; the rachis pubescent; pedicels 5–10 mm. long, incanous, the hypanthium and calyx densely covered with appressed white hair, the underlying tissue not visible; sepals ovate, 4–5 mm. long, 3–3.5 mm. wide, the apex acute or acuminate; corolla subcampanulate disciform, 2.5–3 cm. across, the petals obovate or suborbicular, 1.3–1.5 cm. long, 0.8–1.3 cm. wide, sparsely strigose at the base of the back; stamens ca. 34, the longest 10 mm. long; disc and style glabrous, the style 5 mm. long, slightly divided at the apex, the stigmata clavate, the abaxial surface 1.8 mm. long, the adaxial slightly longer. Capsules obovoid, 7–9 mm. long, 4–7 mm. in diameter, the persistent sepals super-median. Seeds very short-caudate, the embryo 1.5 mm. long, the tail half as long.

CHINA: Shensi: Kan-y-san, *Jos. Giraldi*, June 11–12, 1897 (A); Lao-y-

san, *Jos. Giraldi*, Sept. 6, 1897 (A). Western Hupei: Ichang and vicinity, Gian-gia-kwan, *W. Y. Chun 3555* (A), *3819* (A); Siu-yeh-sie, *W. Y. Chun 3706* (A) = Herb. Nanking no. *4084* (A); Tan-shu-ya, *W. Y. Chun 3758* (A), Wang-sung-gon, *W. Y. Chun 3782* (A); Suon-nai-vok, *W. Y. Chun 4181* (A); same area, *A. Henry 3625* (G, NY), *3949* (A, ISOSYNTYPE, G), *6093* (A, LECTOTYPE); *E. H. Wilson 583* (A, G), *3049* (A); Nan-to, *A. Henry 2143* (G); Fang Hsien, *E. H. Wilson 3047* (A); Hsing-shan-Hsien, *E. H. Wilson 574* (A, G), *3048* (A), *3054* (A), *3055* (A); Chang-lo Hsien, *E. H. Wilson 3051* (A), *3052* (A); Pa-tung Hsien, *H. C. Chow 262* (A, NY), *544* (A, NY), *796* (A), same area, *E. H. Wilson 3053* (A); without precise locality, *C. Silvestri 4370* (A); *A. N. Steward* ex Herb. Univ. Nanking no. *9775* (A); *E. H. Wilson 833* (NY), June 1907 (A).

CULTIVATED: Europe: Hort. Vilmorin (*Wilson 583*) (A); Les Barres, *L. Pandé*, in 1922 (A). Australia: Roy. Hort. Soc. Garden, Wisley (A). United States: Arnold Arboretum *15368* = *6529–3* (*Wilson 574*), without collector, Oct. 7, 1912 (A); *A. Rehder*, July 18, 1918 (A); Arnold Arboretum *7338* (*Wilson 581*), without collector, July 9, 1915 (A), *A. Rehder*, June 24, 1919 (A); Arnold Arboretum *15369* = *6529–4* (*Wilson 583*), without collector, July 9, 1915 (A), Oct. 7, 1912 (A); Highland Park, Rochester, *E. H. Costich*, July 3, 1916 (A); Pa. State College, *R. P. Meahl*, June 1937 (A).

In 1911 E. H. Wilson collected three lots of seeds of this species and numbered them *574*, *581*, and *583*. They all germinated in 1912. Plants from lot *574* flowered in 1918, while those from lots *581* and *583* flowered in 1915. The Vilmorin Nursery also obtained some seed of Wilson's Lot *583*. The United States Department of Agriculture bought some plants from Vilmorin and assigned a number *S. P. I. 73280*. The plant in the Botanical Garden of Pennsylvania State College is from that source.

Forbes & Hemsley interpreted Henry's collection from Nanto, Hupei, as *P. coronarius* Linn. var. *tomentosus* Hook. f. & Thoms. The material that Hooker and Thomson wrote about was from the western Himalayan region. It is altogether different from the species of Central China.

The seeds of this species strongly resemble those of *P. pekinensis* Rupr. The embryo is large and fat with a very short square tail and a crown of rounded lobes. In the density of the indumentum of the leaves *Chow 262* and *544* appear intermediate between *P. incanus* Koehne and *P. sericanthus* Koehne. The upper surface of the leaves of these two specimens is glabrous and the lower surface is pubescent only on the principal nerves and veinlets. They are placed under *P. incanus* on account of their incanous hypanthia.

Steward's collection is distributed under two sets of labels with the same number. The title of one collection is the Flora of Hupeh. It has field data in typewritten form. The title of the other collection is Flora of Honan. It has no field data. For the sublocality it is stamped "Ki-kung-shan," and the date of collection is Aug. 3, 1925. These specimens are identical in all respects. There is confusion in the labels. The one labeled Flora of Hupeh is the correct label.

Judged by the above-cited specimens, this species appears to be geographically isolated and morphologically stable. It is endemic to the eastern end of the Tsinling Range at the confluence of the Han-hsiu and

Yangtze tributaries, on the border of Shensi, Honan and Hupei provinces. There it grows in woods, on cliffs or by the side of streams at altitudes of 600 to 2300 meters. Its white flowers appear in July. With the exception of *Chow 262* and *544* little variation exists.

36a. **Philadelphus incanus** var. **Baileyi** Rehder in Gent. Herb. 1: 27. 1920; et in Jour. Arnold Arb. 5: 153. 1924.

TYPE: *L. H. Bailey*, June 13, 1917 (A).

A low shrub, the branchlets gray, with close and longitudinally rimulose bark, the current year's growth densely strigose, the hairs appressed; leaves ovate, 3–4.5 cm. long, 1.2–2.4 cm. wide, obtuse at the base, acuminate at the apex, the acumen up to 8 mm. long, glabrous above, uniformly strigose beneath, serrate; inflorescences 5- or 7-flowered, the flowers crowded, the rachis 1–2.5 cm. long; pedicels very short, 1–2 mm. long, with the hypanthium and calyx densely strigose, the hairs short, appressed; sepals broad ovate, 4.5 mm. long, 2.5 mm. wide, the apex acute; corolla 2.5 cm. across, the petals obovate, 2.2 cm. long, 0.7 cm. wide, the back glabrous, occasionally with a few crisp weak hairs; stamens ca. 34, the longest 6 mm. long, the anthers subglobose, largely sterile, disc and style glabrous, the style short, 3.5 mm. long, the stigmata subspatulate, appearing sterile; capsules not known.

CHINA: Honan: Chi-kung Shan, border of Hupei and Honan, on the divide between the Yangtze and Hwai-ho, *L. H. Bailey*, June 13, 1917 (A, TYPE; BH), June 16, 1917 (BH).

In the nature of the indumentum this variety resembles *P. incanus* Koehne. In the crowded inflorescences it resembles *P. brachybotrys* Rehder. Its range of distribution is intermediate between that of those two species. The sterility of the anther and stigmata seems to suggest the possibility of it being a natural hybrid of those species. The presence of the adventitious branches and the partially dried, short lateral twigs indicates that the plant was an old one lacking vigor in growth.

37. **Philadelphus reevesianus**, sp. nov.

*Philadelphus incanus* sensu Koehne in Sargent, Pl. Wils. 1: 5. 1911, pro parte.

Frutex 3–4 m. altus, ramulis cinereis vel griseo-cinereis, bienniis longitudinaliter rimulosis, hornotinis scabro-villosis; foliis ellipticis vel ovato-ellipticis, 4–9 cm. longis, 2–5 cm. latis, basi obtusis vel rotundatis, apice acuminatis, acuminibus 5–15 mm. longis, utrinque strigosis, pilis supra erectis, subtus adpressis, margine serratis; inflorescentiis 7- vel 9-floris, rhachibus 2–6 cm. longis, strigoso-villosis; pedicellis 4–5 mm. longis, pilis strigosis, incanis; hypanthiis calycibusque incanis; sepalis ovatis, 6 mm. longis, 3–3.5 mm. latis, apice acuminatis; corolla subcruciformi, 3.5 cm. diametro, petalis oblongis, 1.6 cm. longis, 1 cm. latis, basi dorso strigoso; staminibus ca. 40, antheris oblongis, thecis setosis; discis pubescentibus;

stylis glabris vel basi hirtellis, 5 mm. longis, apice liberis; stigmatibus spathulatis; capsulis subglobosis, 7 mm. diametro, sepalis persistentibus subapicalibus; seminibus breviter caudatis, 2–3 mm. longis, testis fuscis.

CHINA: Hupei: Chang-yang Hsien, *E. H. Wilson 3050* (TYPE, A).
CULTIVATED: Arnold Arboretum *15367* (Veitch trip, *Wilson 915*), flowered July 10, 1912.

The type specimen of this species was collected in central China by Wilson in 1907. Due to its superficial resemblance to *P. incanus* Koehne, it has been erroneously interpreted as that species. Koehne's species has glabrous anthers and disks, while both the spontaneous material of Wilson's collections and the cultivated plant in the Arnold Arboretum have distinctively setose anthers and pubescent disks. In fact, this is the only Old World form with setose anthers, and I consider this character sufficient to give it specific status.

This species is named in memory of my first botany teacher, Dr. Cora D. Reeves, Founder and Head of the Department of Biology, Ginling College, Nanking, China. Her twenty-five years of unselfish service in the field of Chinese Biology have established a permanent monument among Chinese botanists as well as zoologists of my generation.

38. **Philadelphus dasycalyx** (Rehder), stat. nov.

*Philadelphus pekinensis* var. *dasycalyx* Rehder in Jour. Arnold Arb. **1**: 197. 1920. — Hers in Jour. N. China Branch Roy. As. Soc. **53**: 113. 1922; et List. Ess. Lign. Pl. Honan 20. 1922. — Chen, Ill. Man. Chin. Trees Shrubs 373. 1937.

TYPE: N. Honan, Hwei Hsien, *J. Hers 713* (A).

A subscandent shrub, the bark of the second year's growth castaneous, exfoliating; the current year's growth glabrous or glabrescent. Leaves ovate or ovate-elliptic, 3–6 cm. long, 1.2–3.4 cm. wide, obtuse or rounded at the base, acute or shortly acuminate at the apex, subentire, faintly denticulate or serrate, those on the flowering shoot glabrous on both surfaces, except occasionally with a few hairs on the primary nerves beneath. Inflorescence 5- or 7-flowered, the rachis 1.5–4.5 cm. long, villose; pedicels 5–6 mm. long, villose; hypanthium and calyx sparsely villose, the hairs more or less erect; sepals ovate, 5–6 mm. long, 3 mm. wide, the apex acuminate; corolla subdisciform, 2.5 cm. across, the petals obovate, 1.3 cm. long, 1 cm. wide, glabrous, stamens ca. 34, the longest 7 mm. long; disc and style glabrous, the style and stigmata together 6 mm. long, the stigmata clavate, the abaxial surface short, 0.75 mm. long, the adaxial ones twice as long. Capsules obovoid, 6 mm. long, 4.5 mm. in diameter, the persistent sepals subapical. Seed very short-tailed, the testa brown, the embryo 1.8–2 mm. long, the tail one third as long.

CHINA: Honan: Hwei Hsien, on the Shansi border, *J. Hers 713* (TYPE, A). Shansi: Nan-yang Shan, *J. Hers 2729* (A); Chieh-hsiu Hsien, Cho-mei

Shan, *H. Smith 569* (A); Yüan-chü Hsien, Shai-wang-p'ing, *H. Smith 6738* (A); Lu-yah Shan, *H. Smith 8190* (A); Lin-shih Hsien, *T. Tang 865* (A).

CULTIVATED: Highland Park Nursery no. *15*, seed from J. Hers, *R. E. Horsey*, June 24, 1926 (A); Arnold Arboretum no. *20442*, *E. J. Palmer*, June 5, 1936 (A).

This species occurs in western Honan and southern, central, and western Shansi. It grows on slopes of wooded ravines at altitudes of 1300–2500 meters. Its white flowers usually appear in late May and early June. *Smith 8190* was collected in flower in mid-July. All the spontaneous material cited above has glabrous leaves. The vernacular name reported is *Ya-kin-tze*.

Rehder interpreted this taxon as a variety of *P. pekinensis* Rupr. Its short-caudate seeds, crowded inflorescences and small, ovate acuminate leaves resemble those of *P. pekinensis*, but its pubescent hypanthium suggest a closer relationship with the pubescent species of the Sericanthi than with the glabrous plants of the Pekinense.

39. **Philadelphus mitsai**, sp. nov.

*Philadelphus subcanus* sensu Hers in Jour. N. China Branch Roy. As. Soc. **53**: 113. 1923; et List. Ess. Lign. Honan 20. 1922, non Koehne.

*Philadelphus incanus* sensu Rehder in Jour. Arnold Arb. **5**: 153. 1924. — sensu Liu in Bull. Peking Soc. Nat. Hist. **2** (3): 103. 1928, non Koehne.

Frutex humilis, ramulis cinereis, hornotinis crispo-villosis; foliis ovatis, 3–4.5 mm. longis, 1–2.5 cm. latis, basi obtusis, apice acuminatis, acumine 7–10 mm. longo, crasse serratis, supra hispidulis, pilis erectis, subtus sparse villosis; inflorescentiis 7- vel 9-floribus, rhachibus villosis, 2–5 cm. longis, pedicellis 5–6 mm. longis, dense villosis; hypanthiis calycibusque villosis, sepalis ovatis, 6 mm. longis, 3 mm. latis, acuminatis; corolla disciformi, 3 mm. diametro, petalis suborbiculatis, 1.3 cm. diametro; staminibus ca. 33, 5–8 mm. longis; disco piloso, stylo glabro, supra 1/3 diviso; stigmatibus clavatis. Capsula ignota.

CHINA: Honan: Sung Hsien, San-kian-miao, *J. Hers 542* (A, TYPE); Yung-ning, Tsi-li-ping, *J. Hers 402* (A).

Hers' collections were sent to the Arnold Arboretum and were named by A. Rehder as *P. incanus* (*402*), and *P. subcanus* Koehne (*542*). Hers in 1922 published the binomials accordingly. When Rehder enumerated the ligneous plants of northern China in 1924, he put both numbers under *P. incanus* and explained that the specimens under no. *542* differed in their less pubescent leaves from the type and had been tentatively referred to *P. subcanus*, but the character of the pubescence is the same as in *P. incanus*, which seems to be a very variable species. In this treatment Rehder's attention seemed to be focused chiefly on the pubescence of the leaves, and he overlooked the characters of the hypanthium and disk, which to me are more adequate for specific demarkations. The pubescence of the disk of *Hers 542* rules out the possibility of its being *P. incanus*

Koehne. The pubescence of the hypanthium of *P. subcanus* is short, crisp-villose, and appressed, and that of Hers' collections is long, strigose-villose, and erect. Geographically this species is out of the range of both *P. incanus* Koehne and *P. subcanus* Koehne, and morphologically it is different from them. This is a new species. The disk of *Hers 402* is almost glabrous. It is hairy only sparingly. Aside from this, the two specimens are identical in the shape, size, and indumentum of the leaves, in the pubescence of the current year's growth, and in the nature of the hair on the hypanthium. They are from the same area.

The vernacular name "*mi-tsai*" can be translated as "*fuel for rice*," which indicates that the plants are gathered locally as fuel for cooking purposes.

40. **Philadelphus sericanthus** Koehne in Gartenfl. **45**: 561. 1896; in Bot. Jahrb. **29**: 371 (in Diels, Fl. Central-China). 1900, excluding *Giraldi 1655*; in Mitt. Deutsch. Dendr. Ges. **1904** (13): 84. 1904; et in Sarg., Pl. Wils. **1**: 145. 1913. — Schneider, Ill. Handb. Laubh. **1**: 370, *fig. 236 p, 237 m–o*. 1905. — Smith in Jour. Linn. Soc. Bot. **36**: 500. 1905. — Stapf in Bot. Mag. **148**: *pl. 8941*. 1922. — Rehder, Man. Cult. Trees Shrubs 274. 1927; ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 1949. — Chen, Ill. Man. Chin. Trees Shrubs 372. 1937, pro parte. — Bean, Trees Shrubs ed. 7, **2**: 419. 1950; et in Chitt., Dict. Gard. **3**: 1546. 1951.

*Philadelphus sericanthus* var. *rosthornii* Koehne in Bot. Jahrb. **29**: 371 (in Diels, Fl. Central-China). 1900.

*Philadelphus sericanthus* var. *rockii* Koehne, l.c.

*Philadelphus coronarius* var. *chinensis* Lévl., Fl. Kouy-Tchéou 389. 1916, nom. nud.

*Philadelphus magdalenae* sensu Rehder in Jour. Arnold Arb. **12**: 275. 1931, non Koehne.

Lectotype: Hupei: *A. Henry 6015* (A).

Shrub 1–3 m. high, the bark of the second year's growth gray or grayish brown, closed, longitudinally rimulose, gradually peeling off in very small pieces, the current year's growth glabrous or glabrescent. Leaves ovate-elliptic or elliptic-lanceolate, 4–11 cm. long, 1.5–5 cm. wide, obtuse or subrotundate at the base, acuminate at the apex, the acumen 8–15 mm. long, serrate, sparsely strigose or subglabrous above, sparsely strigose on the primary nerves beneath. Inflorescence 7- up to 15-flowered, rarely 5- or on weak branchlets 3-flowered; the lowest pair or pairs usually in the axils of normal leaves, the central axis glabrous or glabrescent; pedicels 6–12 mm. long, strigose, or those of the lower flowers strigose only on the apical ends; hypanthium and calyx strigose, the hairs white, not completely covering the tissue underneath; sepals ovate, 6–7 mm. long, 3 mm. wide, the apex acuminate; corolla subcampanulate disciform, 2.5 cm. across, the petals obovate, 1.3 cm. long, 1 cm. wide, sparsely strigose on the basal portion outside; stamens ca. 35, the longest 7 mm. long, the anthers glabrous; disc and style glabrous, the style 6 mm. long, the upper fourth to

half divided, the stigmata spatulate, the abaxial surface 1.5 mm. long, the adaxial slightly longer. Capsules obovoid, 7 mm. long, 5 mm. in diameter. Seed short-tailed, the embryo 1.5–1.8 mm. long, slightly longer than the tail, the testa castaneous, reticulate.

CHINA: Kiangsi: Lu-Shan, *C. Y. Chiao* ex Univ. Nanking Herb. no. *18553* (NY); *H. H. Chung & S. C. Sun 603* (NY); *Y. Tsiang 1070* (NY); *A. N. Steward* ex Univ. Nanking Herb. no. *2470* (MO, NY); Kiangsi-Hupei-Hunan border: *Y. K. Hsiung 5600* (A), *5699* (A). Western Hupei: Pa-tung Hsien, *E. H. Wilson 796* (NY), *1007* (NY); *H. C. Chow 493* (A, NY); vicinity of Ichang, *A. Henry 6015* (A LECTOTYPE; G, NY), *5344* (G), *7428* (G); *E. H. Wilson 1282* (A, NY). Northeastern Hunan: Mo-fu-shan, *Y. K. Hsiung 5149* (A). Eastern Szechuan: Ta-ning Hsien, *E. H. Wilson 4496* (A); Nan-chuan, *W. P. Fang 644* (A), *905* (A), *989* (A), *1063* (A, NY), *1194* (A); *C. Bock & A. von Rosthorn 472* (A, ISOSYNTYPE of *P. sericanthus* var. *rosthornii* Koehne), *1918* (photo A, HOLOTYPE of *P. sericanthus* var. *bockii* Koehne), *1926* (A, ISOSYNTYPE of *P. sericanthus* var. *rosthornii* Koehne). Eastern Kweichow: Fan-ching Shan, *Steward, Chiao & Cheo 609* (A, NY); San-hoa, *Y. Tsiang 6451* (A, NY); Tou-chan, *J. Cavalerie* ex Herb. Bodinier *2343* (photo and fragment of HOLOTYPE of *P. coronarius* var. *chinensis* Lévl., A); Tuh-shan, *Y. Tsiang 6633* (A); Anlung, *Y. Tsiang 7433* (A). Yunnan: *E. E. Maire* ex Herb. Bonati *3644* (NY).

CULTIVATED: Europe: Hort. Bot. Dahlem, *R. Schlechter*, June, 1924 (A). United States: Arnold Arboretum, *A. Rehder*, June 23, 1902 (A); *4617*, *C. E. Faxon*, June 28, 1905 (A), June 25, 1909 (A), June 21, 1910 (A) (some flowers paniculate), June 21, 1911 (A); *A. Rehder*, Oct. 7, 1907 (A); *G. M. M.*, June 22, 1923 (BH). Canada: Dominion Arboretum and Botanic Gardens, Ottawa *21–69–1*, *J. M. Gillett*, July 3, 1935 (BH).

The Vilmorin Nursery of France introduced and distributed this species to European and American gardens. The plant in the Arnold Arboretum was obtained from Vilmorin, and that in the botanic garden at Ottawa was received from the Royal Botanic Gardens at Kew.

Koehne cited three specimens, designating no type. *Henry 6015* is here selected as the lectotype.

Koehne in 1900 on the basis of C. Bock and A. von Rosthorn's collection from Manchuan, southwestern Szechuan, described two varieties. *Philadelphus sericanthus* var. *bockii* Koehne was established on the strength of the smaller leaves and flowers. The photograph of the type (*Rosthorn 1918*) indicates that the material was collected from a much-branched old growth, which naturally produces smaller leaves and flowers. I can see no reason for keeping it as a variety. *Philadelphus sericanthus* var. *rosthornii* Koehne was published on the basis of *Bock & Rosthorn 1919*, *1926*, *1927*, and *472*. In the original description Koehne did not list a single stable character for the variety. Not only does every statement allow for variation, but also most of the statements contain alternatives. Before me are *Bock & Rosthorn 472* and *1926*. The latter is flowering material. It is identical with *Henry 6015*, a lectotype of *P. sericanthus* Koehne. *Bock & Rosthorn 472* is a fruiting specimen. The compressed hairs on its leaves suggest *P. henryi* Koehne.

*Philadelphus sericanthus* Koehne is endemic to Central China, with the famous Wu-Shan as the center of its range. Hence its range extends westward to eastern Szechuan, where it has been recorded from Ta-ning and Man-chuan districts, southward to eastern Kweichow, and southeastward to the Kiangsi-Hupei-Hunan border. Material from the periphery of this range has a more strigose upper leaf surface than the typical specimens. It is a shrub occurring in lightly shaded woods or thickets at altitudes of 500–1000 meters. Most field notes record it as one to three meters high. Steward, Chiao, & Cheo have recorded it as a tree five meters high with a trunk fifteen cm. in diameter. If this observation was made by either Steward or Chiao, I must accept the fact that some members of the genus *Philadelphus* are trees. However, knowing that there is no arborescent form in this genus, it is probably safe to assume that this observation was a mistake on the part of Cheo, whose botanical knowledge is limited.

Up to the present I have not learned the vernacular name of this species. No collector has ever recorded it. Chen in 1937 tried to assign a Chinese name to it. Léveillé published *P. coronarius* Linn. var. *chinensis* Lévl. on the basis of J. Cavalerie's collection ex Herb. Bodinier no. *2343*. Rehder saw the holotype of this trinomial and interpreted it as a glabrescent form of *P. magdalenae* Koehne. Typical *P. magdalenae* has a pubescent disk and leaves which are uniformly pubescent on both surfaces. Cavalerie's specimen has a glabrous style and disk and leaves glabrous except on the primary nerves beneath. It is a typical *P. sericanthus* Koehne. *Tsiang 6451* in the New York Botanical Garden has paniculate inflorescences, while that in the Arnold Arboretum has racemose ones. This is another illustration of the tendency toward branching of the lower elements of the inflorescences of the genus.

This species was introduced into western gardens by Father Farges, who was stationed in Cheng-Kou (Tschen-Kéu) of eastern Szechuan and who collected plants, specimens, and seeds for French institutions. In 1897 Farges' seed reached M. L. de Vilmorin, who numbered it *7183*. From this lot the Arnold Arboretum obtained a plant in 1902, which marked the date of the introduction of this species into the New World. Bean recorded its introduction into England by Wilson in 1900. I have not seen any cultivated material of this introduction. At the Arnold Arboretum it flowers in the latter part of June. Cultivation does not seem to affect the size of the flower or the nature of its indumentum. Besides its late flowering period it warrants little merit. The flowers are small and the habit stiff.

40a. **Philadelphus sericanthus** var. **kulingensis** (Koehne) Hand.-Mazz., Symb. Sin. **7**: 439. 1931. — Chen, Ill. Man. Chin. Trees Shrubs 372. 1937.

*Philadelphus incanus* var. *sargentianus* forma *kulingensis* Koehne in Fedde, Repert. Nov. Sp. **10:** 126. 1911; et in Sarg. Pl. Wils. **1**: 145. 1912.

*Philadelphus sericanthus* var. *rehderianus* sensu Cheng in Contr. Biol. Lab. Sci. Soc. China Bot. **10**: 114. 1936, non Koehne.

*Philadelphus sericanthus* sensu Chen, Ill. Man. Chin. Trees Shrubs 372. 1937, non Koehne.

TYPE: Kiangsi: *E. H. Wilson 1669* (A).

An erect shrub, the second year's growth brownish gray, the bark closed, longitudinally rimulose, the current year's growth glabrous or glabrescent; leaves ovate-elliptic, 5–8.5 cm. long, 2.5–4 cm. wide, acute or obtuse at the base, acuminate at the apex, the acumen 5–10 mm. long, sharply and prominently serrate, 9–12 teeth on each side, glabrous above, sparsely pilose on the principal nerves or on the nerves and veinlets beneath; inflorescence 7-, 9-, or 11-flowered; pedicels glabrous, 10–25 mm. long; hypanthia and sepals partially and sparsely pilose, the hairs appressed; capsules obovoid, 7–9 mm. long, 6–7 mm. in diameter.

CHINA: Chekiang: Hang-chow, *E. D. Merrill 11271* (A). Kiangsi: Kuling, *E. H. Wilson 1669* (A, TYPE); Lu-shan, *H. H. Chung & S. C. Sun 215* (NY), *396* (A, NY).

This variety differs from the typical *P. sericanthus* in having partially pubescent hypanthia and sepals. In the reduction of the density of hairs on the hypanthia this variety approaches *P. brachybotrys* var. *laxiflorus* (Cheng) S. Y. Hu. Cheng in 1936, on the basis of *M. Chen 649*, *K. K. Tsoong 366*, and *S. Chen 212*, reported *P. sericanthus* var. *rehderianus* Koehne to occur in western Chekiang. Koehne's trinomial was based on a plant collected on the high plateaus of Sung-pan in western Szechuan. Although I have not seen any of these three specimens, from a phytogeographical point of view the material of the maritime province Chekiang cannot be identical with that of the Sino-Tibetan plateau. Very likely Cheng's material belongs here, as western Chekiang supports a flora similar to that of the Central Yangtze Basin, where Kuling is located.

41. **Philadelphus henryi** Koehne in Fedde, Rep. Sp. Nov. **10**: 126. 1911. — Lévl., Cat. Pl. Yunnan 255. 1917. — Rehder in Jour. Arnold Arb. **12**: 275. 1931. — Hand.-Mazz., Symb. Sin. **7**: 437. 1931.

*Philadelphus nepalensis* sensu Lévl., Cat. Pl. Yunnan 255. 1917, non Koehne.

*Deutzia mollis* var. *erythrocalyx* Lévl. ex Rehd. in Jour. Arnold Arb. **12**: 275. 1931, in syn.

LECTOTYPE: *A. Henry 10749* (A).

A shrub 1.5–2.5 m. high, the bark of the second year's growth castaneous, closed, tardily exfoliate, the current year's growth crisp-hirsute. Leaves ovate or rarely ovate-lanceolate, 3.5–8 cm. long, 1.5–4 cm. wide, rounded or obtuse at the base, acuminate at the apex, the acumen 5–15 mm. long, sparsely or uniformly scabrid above, scabrid-strigose on the primary nerves or veinlets beneath, subentire or faintly denticulate, rarely serrate. Inflorescence 5- up to 22-flowered, rarely on weak branchlets 1-flowered,

racemose, rarely paniculate, the rachis 3–9 cm. long; pedicels 4–5 mm. long, densely scabrid; hypanthium and calyx crisp-pilose, the underlying tissue visible; sepals ovate, lanceolate, rather sparsely pilose; corolla subdisciform, 2.5–3 mm. across, the petals oblong, 1.3 cm. long, 8–11 mm. wide, the back glabrous; stamens ca. 38, the longest 7 mm. long, the anthers oblong, the disc and style glabrous, 5.5 mm. long, the stigma oar-shaped, the abaxial surface 2 mm. long, the adaxial narrower, slightly longer or almost wanting. Capsules obovoid; 6 mm. long, the apical end 6 mm. in diameter, the persistent calyx subapical. Seed short-caudate, the testa castaneous, reticulate, the embryo 1.5 mm. long, the tail 1.5 mm. long.

CHINA: Southwestern Szechuan: Ma-pien Hsien, *F. T. Wang 23017* (A); Wa-shan, *E. H. Wilson 3040* (A); Minya Konka Snow Range, east of Yu-long Hai, *J. F. Rock 17624* (A, NY). Yunnan: Mengtze, *A. Henry 10749* (A, LECTOTYPE; NY), *10749A* (MO, NY, US), *10749B* (A); Pé-long-tsin, *E. E. Maire* (A, HOLOTYPE of *Deutzia mollis* var. *erythrocalyx* Lévl. ex Rehder); Kun-ming (Yunnanfu), *O. Schoch 148* (A, US); Cheng-kiang, *Y. Tsiang & H. Wang 16141* (A); Cheng-kang Snow Range, *T. T. Yu 16951* (A); Yang-pi, *McLaren, C. collection 138* (A); Ping-pien Hsien, *H. T. Tsai 62399* (A); Ta-li Range, *G. Forrest 5032* (A).

This species was first recorded from Mengtze in southwestern Yunnan. Representatives from central and western parts of that province have been collected in recent years. *Wang 23017* extends its range far north into southwestern Szechuan. It has an altitudinal range of 1500–3380 meters. The specimens collected from western Yunnan resemble *P. delavayi* L. Henry in vegetative characters and in the form of the stigma. It is because of their pubescent hypanthia that they are placed here. In Yunnan the white flowers of this species appear as early as May in the southwest part of the province and as late as July in the northeast.

In his original description Koehne cited *A. Henry 10749 and 10749B*, without designating a type. In the herbarium of the Arnold Arboretum a detailed note in Koehne's handwriting is attached to *10749*, and this specimen is selected as the lectotype.

Diels named *Forrest 5032 P. nepalensis*. This specimen in the herbarium of the Arnold Arboretum has pubescent hypanthia and leaves. It is different from the glabrous Himalayan species. *Wilson 1772*, cultivated in the Arnold Arboretum, flowered in June 1910. It appears to belong here.

41a. **Philadelphus henryi** Koehne var. **cinereus** Hand.-Mazz., Symb. Sin. 7: 438. 1931.

*Philadelphus cinereus* Hand.-Mazz. in Karsten & Schenck, Vegetationst. 20 (7): [15]. 1930, *nom. nud.*; et Symb. Sin. 7: 438. 1931, in syn.

TYPE: Yunnan, *Handel-Mazzetti 6181* (Vienna).

A shrub up to 3 m. high, the current year's growth cinereo-hirtellous; leaves ovate-lanceolate or ovate on vegetative shoots, 3.5–6 cm. long, 1–3 cm. wide, obtuse at the base, acuminate rarely acute at the apex, subentire

or faintly denticulate, uniformly scabrid-strigose on both surfaces; inflorescence 7- up to 17-flowered, racemose or often paniculate; pedicels, hypanthia and calyx cinereous, crisp-villose; corolla subdisciform, 2.5 cm. across, the petals suborbicular, 1.1 cm. in diameter.

CHINA: Yunnan: Chen-hsiung Hsien, *H. T. Tsai 52244* (A); central Yunnan, Lo-shiuek Mts., *McLaren's collectors, U 137* (A); La-pa-ho, *Siméon Ten 195a* (A); Yung-ning-Yung-peh, *C. Schneider 3505* (A).

42. **Philadelphus tenuifolius** Rupr. ex. Maxim. in Bull. Phys.-Math. Acad. Sci. St. Pétersb. **15**: 133. 1856; et in Mél. Biol. **2**: 425. 1857. — Rupr. in Bull. Phys.-Math. Acad. St. Pétersb. **15**: 365. 1857. — Maxim., Prim. Fl. Amur. 108. 1859. — Koehne, Deutsche Dendr. 182. 1893; in Gartenfl. **45**: 597. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904**(13): 84. 1904. — Forbes & Hemsl. in Jour. Linn. Soc. Bot. **23**: 278. 1887. — Schneider, Ill. Handb. Laubh. **1**: 372. 1905. — Yabe, Icon. Fl. Manch. **1**: *pl. 18*. 1920. — Minami, List Pl. Manch. Mong. 183. 1926. — Nakai, Chosen-shokubutsu **1**: 335, *fig. 413*. 1914; in Bot. Mag. Tokyo **29**: 64. 1915; et Fl. Sylv. Kor. **15**: 52. 1926. — Nekrasowa, Fl. As. Russ. I. **3**: 3. 1924. — Chen, Ill. Man. Chin. Trees Shrubs 374. 1937. — Poiarkova in Komarov, Fl. SSSR **9**: 221, *pl. 13*, *fig. 1*. 1939. — Kitagawa, Lineam. Fl. Mansh. 253. 1939. — Rehder, Man. Cult. Trees Shrubs 276. 1927; ed. 2, 270. 1940; et Bibl. Cult. Trees Shrubs 193. 1949.

*Philadelphus coronarius* var. *tenuifolius* Maxim. in Mém. Acad. Sci. St. Petersb. VII. **10**(16): 38 (Rev. Hydrang. As. Or.). 1867. — Dippel, Handb. Laubh. **3**: 336. 1893.

*Philadelphus coronarius* sensu Regel, Tent. Fl. Ussur. 62. 1861, non Linn.

*Philadelphus tenuifolius* forma *subinteger* Komarow in Bull. Jard. Bot. Russe **16**: 172. 1916. — Nekrasowa, Fl. As. Russ. I **3**: 4. 1924.

*Philadelphus tenuifolius* forma *dentata* Komarow, l.c. — Nekrasowa, l.c.

*Philadelphus tenuifolius* forma *multiflorus* Komarow, l.c.

*Philadelphus viksnei* Zamelis in Acta Hort. Bot. Univ. Latv. **11–12**: 232, *pl. 1*. 1939.

*Philadelphus robustus* Nakai in Jour. Jap. Bot. **19**: 372. 1943.

TYPE: *Ruprecht* (Herb. Acad. Sci. USSR).

An upright shrub 1–3 m. high, with arching branches, bark of the second year's twigs brownish gray, rarely chestnut-brown, moderately exfoliate; the current year's growth pubescent, the hairs compressed. Leaves on the vegetative shoots ovate, up to 10.5 cm. long, 6 cm. wide, remotely dentate, sparsely villose on the primary nerves and at their angles beneath, otherwise glabrous, the base acute, obtuse or rarely roundish; the apex abruptly short-acuminate; leaves of the flowering twigs ovate or elliptic, 4–6.5 cm. long, 2–3 cm. wide, glabrescent and barbate beneath, very sparsely pilose above, acute, obtuse or roundish at the base, acute or short-acuminate at the apex, remotely serrate or subentire. Flowers

slightly fragrant, 5 or 7 (rarely 3 or 9) in a raceme, the pedicels rather long, usually longer than the hypanthium plus the calyx, densely pubescent, the sepals ovate, 5 mm. long, sparsely pubescent; corolla 2.5 cm.–3.4 cm. across, the petals obovate-oblong, 1–1.5 cm. long, 0.6–1 cm. wide; stamens 25–30; style and disk glabrous, the style half divided, the abaxial stigmatic surface equal to or half the length of that of the adaxial one. Capsules obconic, rounded at the apical end, 4.5–6 mm. long, 5 mm. in diameter, the persistent sepals subapical. Seeds short-caudate.

EASTERN SIBERIA: Amur: Korfowskaja, *S. J. Enander*, Aug. 3, 1913 (A). Manchuria: Er Tieng Tien Tze, *P. H. Dorsett 3059* (A); Kirin, *F. H. Chen 263* (A).

KOREA: *K. G. Gilbert 57* (A); Taiyudo, French mine, *E. H. Wilson 8635* (A, US); South Keisho, Chirisan, *E. H. Wilson 9619* (A); Keiki, Keijyo, *E. H. Wilson*, May 13, 1914 (A); Tsü-sima Island, *C. Wilford 1859* (G).

CULTIVATED: Europe: Hort. Bot. Berol., *E. Koehne 364* (A, G); Royal. Bot. Gard., Edinb., *D. Drysdale*, June 19, 1929 (A). United States: Arnold Arboretum *4654*, without collector, in 1904 (A), *S. Y. Hu*, June 13, 1951 (A).

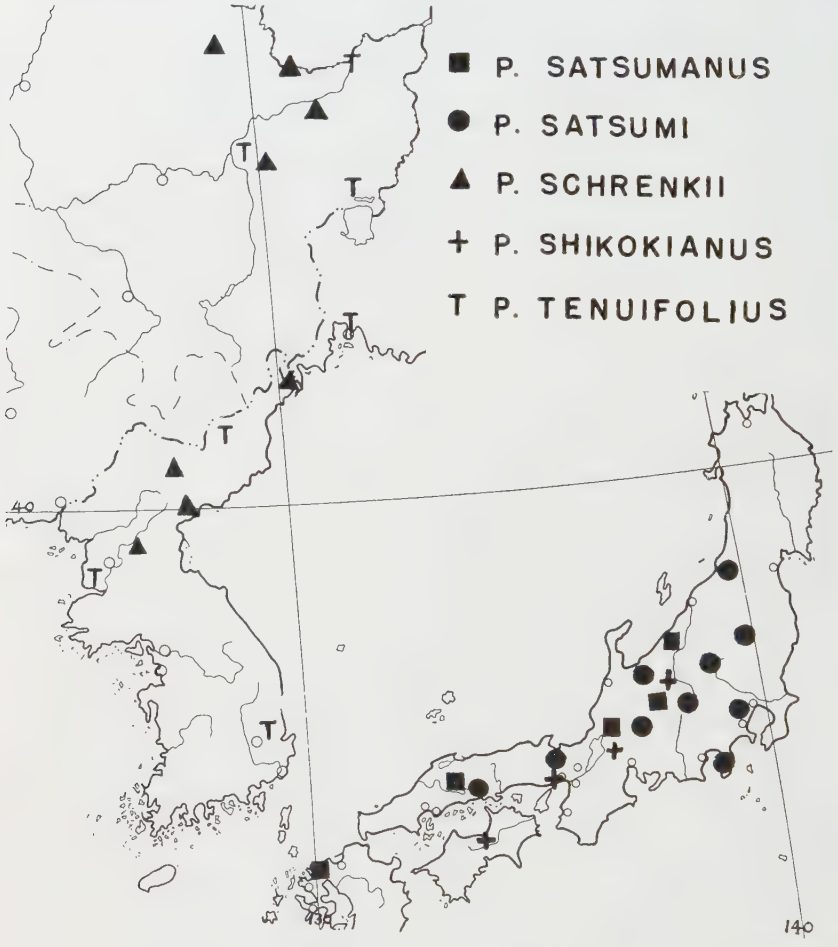
The natural range of this species is the valley of the Amur River and its tributaries, the Sungari and Ussuri Rivers, hence southward to Vladivostok and South Korea (Map 6). In its natural home it is a very common bush at altitudes of 150 to 900 m. It flowers in mid-June, the flowers being slightly fragrant.

Ruprecht and Maximowicz differentiated their species from *P. coronarius* Linn. by their smaller size, weaker branches, cinereous bark, submembranaceous and deeper green leaves, smaller and inodorous flowers, and subundulate petals. They compared the spontaneous *P. tenuifolius* of the Amur River region, where it was subjected to long continued cold weather, with the cultivated *P. coronarius* of the European gardens. But the living specimens of the two species growing side by side in the Arnold Arboretum do not exhibit any appreciable differences in habit, size of branches, or even in the texture of the leaves. The brownish gray bark of the two-year-old growth, the compressed hairs on the lower surface of the leaves, the faint fragrance of the flowers, and the short-tailed seeds are distinguishing characters of *P. tenuifolius*. In its seed characters this species seems to be closer to *P. pekinensis* than to *P. coronarius*.

Zamelis' description of *P. viksnei* was based on a plant raised from seed collected in Vladivostok. He distinguished it from *P. tenuifolius* by its "statura erecta, foliis floribusque majoribus." The photograph of the type plant appears to resemble the *P. tenuifolius* in our garden. Judging from the published notes of the hybridization work he did with Pochlaks, there seems to be no *P. tenufolius* in the botanical garden of the University of Latvia. Possibly Zamelis did not have the true *P. tenuifolius*, and his comparison of the habit of his new entity, including the leaf and flower sizes, with *P. tenuifolius* may have been derived from books, perhaps from Maximowicz' observations. Since cultivation inevitably changes the aspect of a plant, the better soil and care in the garden often resulting in larger plants, and as Vladivostok is within the natural range of distribution of

*P. tenuifolius*, I see no reason for keeping *P. viksnei* as a distinct species.

Komarow described three forms on the basis of the number of teeth on the leaf margin and the number of flowers in the inflorescence. He designated specimens with more or less entire leaves as forma *subinteger*, those with ten to twenty teeth as forma *dentatus*, and those with nine to eleven




MAP 6. The distribution of the species of *Philadelphus* in northeastern Asia and Japan.

flowers as forma *multiflorus*. Arnold Arboretum no. *4654* was introduced from Germany in 1902. Specimens collected in 1904 have thick two-year-old branches bearing many flowering twigs. This plant has been propagated vegetatively from time to time. In 1951 these plants showed signs of debility. There were no thick branches bearing a large number of

flowering twigs. Moreover, each flowering twig bore only one, two, or three flowers. The leaves of the few small virgin shoots are dentate, as are those collected in 1902. This plant is a good illustration of the variation of the leaf-margins, the number of teeth varying with the age and vitality of the plant. The number of flowers on a flowering twig seems to tell the same story. For this reason there seems to be no valid reason for accepting Komarow's three forms.

42a. **Philadelphus tenuifolius** var. **latipetalus**, var. nov.

Frutex erectus; foliis ovatis, usque ad 11 cm. longis et 6 cm. latis, basi rotundatis vel obtusis, apice acuminatis; margine denticulatis; racemis 5- vel 7-floris, floribus 3 cm. diametro, petalis suborbiculatis, 8 mm. diametro; stylo et disco glabris.

MANCHURIA: *B. V. Skvortzov*, June 6, 1925 (TYPE, A).

This variety differs from typical *P. tenuifolius* chiefly in its suborbicular petals, which result in a discoid appearance of the corolla.

43. **Philadelphus subcanus** Koehne in Mitt. Deutsch. Dendr. Ges. **1904**(13): 83. 1904; et in Sargent, Pl. Wils. **1**: 4. 1911. — Dunn in Jour. Linn. Soc. Bot. **39**: 475. 1911. — Rehder, Man. Cult. Trees Shrubs 274. 1927; ed. 2, 268. 1940; et Bibl. Cult. Trees Shrubs 192. 1949. — Engler, Pflanzenf. ed. 2, **18a**: 194. 1930. — Chen, Ill. Man. Chin. Trees Shrubs 372. 1937.

*Philadelphus wilsonii* Koehne in Sargent, Pl. Wils. **1**: 4. 1911, **1**: 145. 1912. — A. O[sborn] in Gard. Chron. III. **114**: 186, *fig. 93*. 1943.

*Philadelphus subcanus* var. *wilsonii* (Koehne) Rehder in Jour. Arnold Arb. **1**: 196. 1920; Man. Cult. Trees Shrubs 274. 1927; ed. 2, 268. 1940; et Bibl. Cult. Trees Shrubs 192. 1949. — Chen, Ill. Man. Chin. Trees Shrubs 372. 1937. — Bean in Chitt., Dict. Gard. **3**: 1546. 1951.

*Philadelphus sericanthus* var. *rehderianus* Koehne in Fedde, Repert. Nov. Sp. **10**: 127. 1911; et in Sarg., Pl. Wils. **1**: 145. 1912. — Chen, Ill. Man. Chin. Trees Shrubs 372. 1937.

*Philadelphus paniculatus* Rehder in Jour. Arnold Arb. **11**: 159. 1930.

TYPE: Szechuan, *A. Henry 8823*.

A stiff erect shrub 3–6 m. high; the second year's growth brown or grayish brown, the bark closed, tardily exfoliating, the current year's growth brown, glabrous or glabrescent. Leaves ovate or ovate-lanceolate, 4–14 cm. long, 1.5–7 cm. wide, rounded or obtuse at the base, acuminate at the apex, the acumen 0.5–1.5 cm. long, faintly denticulate or those on the vegetative shoots finely serrate, sparsely hirsute above, the hairs erect, villose on the nerves beneath. Inflorescences essentially racemose, occasionally on vigorous shoots paniculate, 5- up to 25-flowered, generally 9- or 11–flowered, the rachis 2.5–22 cm. long, villose and glabrescent; the peduncles of individual cymes, when present, 6–12 mm. long, the pedicels 5–10, rarely up to 13 m. long, densely crisp-villose; hypanthium and

calyx crisp-villose, the hairs grayish yellow with the underneath tissue visible; sepals ovate, 6–7 mm. long, 3–4 mm. wide, the apex acuminate; corolla disciform, 2.5–3, rarely up to 4 cm. across, the petals suborbicular or obovate, rarely ovate, 1.3–1.8 cm. long, 9–1.3 cm. wide, generally setose on the lower portion of the back; stamens about 33, the longest 9–10 mm. long; disc pubescent, the style 6 mm. long, the lower portion pubescent, the stigmata subspatulate, the abaxial surface 1.5–2 mm. long, the adaxial equal but obscure, or wanting. Capsules obovoid, 8–10 mm. long, 6 mm. in diameter, the persistent calyx subapical. Seeds very short caudate, the testa brown, the embryo 1.5 mm. long, the tail one fourth as long, the lobes of the crown rounded.

CHINA: Szechuan: Mao Hsien, *F. T. Wang 21910* (A); Kuan Hsien, *W. P. Fang 2237* (A, TYPE of *P. paniculatus* Rehd.), *2349* (A); same area, Panlun Shan, *E. H. Wilson 4297* (A); Wen-chuan, Wa-ssu County, *E. H. Wilson 3041* (A, TYPE of *P. wilsonii* Koehne), *3043* (A); Li-fan, *F. T. Wang 21564* (A); Mao-kung Hsien, *F. T. Wang 21274* (A); Juei-she Hsien, *T. T. Yu 1037* (A); Mt. Omei, *C. Y. Chiao & C. S. Fan 554* (A); *W. P. Fang 2799* (A), *6738* (A), *12837* (A); *Y. S. Liu 1208* (A), *1474* (A), *7622* (A, NY); *C. L. Sun 351* (BH); *F. T. Wang 23344* (A); *E. H. Wilson 4883* (A); Sung-pan, *H. Smith 2741* (A); without precise locality, *W. P. Fang 6728* (NY). Sikang: (Western Szechuan): Mu-pin, *E. H. Wilson 3039* (A); Tai-chien-lu, *E. H. Wilson 3042* (A), *4384* (A); Minya Konka Snow Range, east of Yu-long Hai, *J. F. Rock 17624* (A, NY, US). Yunnan: Pin-chuan Hsien, *H. T. Tsai 52974* (A).

CULTIVATED: Arnold Arboretum *7828–1 = 6529 = Wilson 1247*, without collector, 1911 (A); Arnold Arboretum 312–29, *E. R. Sears*, June 21, 1935 (BH); Highland Park, Rochester, N.Y., *R. E. Horsey*, May 31, 1918 (BH); Borderland, North Easton, Mass., *Oaks Ames*, June 23, 1917 (BH).

Koehne established *P. subcanus* on the basis of *A. Henry 8823*, a specimen collected from Szechuan. I have not seen the type of this species. According to Koehne, it has a dark brown current year's growth which becomes glabrous at anthesis; ovate leaves 4.5–11.5 cm. long, 2.2–8 cm. wide, with short scattered hairs above and rather dense hirsute hairs on the nerves beneath; hypanthium with grayish yellow tomentum and short crisp hairs; small flowers 2.2 cm. in diameter with orbicular petals; about 30 stamens and style pubescent below the middle.

Before me there are four specimens of Wilson's western Szechuan collection, nos. *3039*, *3042*, *3043* and *4883*, which were named by Koehne as *P. subcanus*. These specimens fit well Koehne's description in the above-mentioned characters. No. *3043* from Wen-chuan and no. *4883* from Mt. Omei have almost glabrous petals. No. *3039* from Mu-pin evidently has golden setose hairs at the base on the outside of the petals. No. *3042* from Ta-chien-lu consists of three fragments in the Arnold Arboretum. One of these has glabrous petals, another has distinctly golden setose petals, and the third is intermediate, with most petals glabrous and some inconspicuously setose. This specimen also exhibits a considerable variation in the shape and size of the leaves. Take the largest leaves of different flowering twigs on the same branchlet for comparison — in shape they vary from

ovate to lanceolate and in size from 9 cm. long and 3.5 cm. wide to 5 cm. long and 1.5 cm. wide. The largest leaf of a vegetative shoot on the same sheet is 13 cm. long and 7.3 cm. wide.

In 1911 Koehne established *P. wilsonii*, based on a specimen collected by Wilson in Wen-chuan. In a note he remarked that this species is allied to *P. subcanus*, from which it differs chiefly in the unusually large leaves on the flowering shoot. The type of this species, *Wilson 3041*, was apparently collected from a vigorously growing plant, and consequently it has larger leaves. But such large leaves are not confined to this collection. *Wilson 3042*, which was named *P. subcanus* by Koehne also has leaves reaching similar size. In the nature of the indumentum and the flower characters, *Wilson 3041*, the type of *P. wilsonii* Koehne, is identical to the above-mentioned Wilson numbers, especially *3039*. On the basis of the morphological similarities and geographical distribution all these specimens should belong to one species, and *P. subcanus* Koehne has priority.

Another species from the general area was published by Rehder in 1930 on the strength of its paniculate inflorescences. Rehder maintained that that species, *P. paniculatus*, seems to be most closely related to *P. sericanthus* Koehne and *P. subcanus* Koehne. The type of this species, *W. P. Fang 2237*, from Kuan-Hsien, is a fruiting specimen. Compared with the above-mentioned Wilson collection, the hairs on the nerves of the lower surface are more scattered. But the age of the leaves may account for such reduced density of indumentum. The infructescences of this specimen are paniculate. This condition is not uncommon among the *Philadelphus* species of West China. The vigorously growing branches of a species that normally bears racemose inflorescences often produce paniculate ones. For example, *Wilson 3043* from Wen-chuan has largely racemose inflorescences, but the pedicels of the lowest pairs of flowers of one of them tend to branch and give rise to cymes. *Wilson 4384* from Ta-chien-lu has two flowering twigs. The lower one has eleven flowers in a normal racemose arrangement and the upper one on the same branchlet has nineteen flowers arranged in a paniculate pattern. This specimen was named *P. wilsonii* by Koehne, and later it was changed to *P. subcanus* var. *wilsonii* (Koehne) Rehder. If the paniculate portion of this specimen should be cut off and placed on *Fang 2237*, the type of *P. paniculatus* Rehd., there would be no reason for anybody to suspect that these elements were from two different collections. Furthermore, Wen-chuan Hsien, the type locality of *P. wilsonii* Koehne, and Kwan Hsien, the type locality of *P. paniculatus* Rehder, are adjacent counties in northwestern Szechuan, situated at the point where the Min River emerges from the rugged mountains. That area I know best, for I spent five summers traveling through it studying the vegetation and collecting plant specimens. From a phytogeographical point of view the localities where the types of *P. wilsonii* Koehne and *P. paniculatus* Rehder were collected are in one inseparable unit. They support the same type of vegetation. Both morphological and geographical evidence indicate that *P. paniculatus* Rehder and *P. wilsonii* Koehne are conspecific, and in my opinion they are both synonymous with *P. subcanus* Koehne.

The crisp golden hairs on the capsules of the type of *P. sericanthus* var. *rehderianus* Koehne clearly indicate that this material is a fruiting specimen of *P. subcanus*. Koehne established this trinomial on the strength of the large ovate leaves which are glabrous above. The data on the label of this material say that the specimen was collected in October. Sung-pan, the type locality of this trinomial, is situated on the high plateau of northwestern Szechuan; the general altitude is 2740 meters. Its growing season is short. Thus the leaves on this specimen are falling, and those left on the plant are too old to show adequately the characters of their pubescence. I can see no reason for keeping that variety under *P. sericanthus*.

The description of the seed is drawn from *Wilson 4384* from Ta-chien-lu. *Chiao & Fan 554* from Mt. Omei has seeds with longer tails, which are as long as the embryos. *Philadelphus subcanus* Koehne is a species of western Szechuan. Its range extends from the Chun-lai Range westward to eastern Sikang up the highlands of Ta-chien-lu, and southward to northern Yunnan as far as Long. 100° 35′ E. and Lat. 25° 44′ N. The indumentum on the leaves and the type of stigma suggest a close relationship with *P. henryi* Koehne. The latter species has a glabrous style. In western Szechuan this species grows in forests at altitudes of 1850–3050 meters. It has been recorded as a shrub from two to six meters high. The white flowers appear in June. E. H. Wilson introduced this species to the Arnold Arboretum and the Vilmorin Nursery in 1908. The plant in the Arnold Arboretum flowered in 1911.

KEY TO THE VARIETIES OF *P. subcanus*

A. Hypanthia villose sublanate; base of the back of the corolla pilose. . . . . a. var. *dubius*.

AA. Hypanthia weak villose, the hairs crisp; back of the corolla glabrous. . . . . b. var. *magdalenae*.

43a. **Philadelphus subcanus** var. **dubius** Koehne in Sargent, Pl. Wils. 1: 4. 1911.

LECTOTYPE: Szechuan, *Wilson 4044* (A).

Shrub 1.5–3 m. high, bark of the second year's growth brown, tardily exfoliate; the current year's growth villose, the hair crisp. Leaves ovate, 2–7.5 cm. long, 1.5–3.5 cm. wide, on sterile shoots up to 9 cm. long, 5 cm. wide, rounded or obtuse at the base, acute or shortly acuminate at the apex, serrate, hirsute above, uniformly villose-sublanate beneath; inflorescences 7- or 9-flowered, the pedicels, hypanthium and calyx long-villose-sublanate; flowers disciform, 2.5 cm. across, the petals suborbicular, nearly glabrous outside with a few hairs at the base; stamens about 30; base of style with a few weak white hairs.

CHINA: Szechuan: West of Wan Hsien, Pan-lan-Shan, *Wilson 4044* (A, TYPE).

This variety is known only from the type collection. Koehne recognized it as a variety on the strength of the constant loosely pilose stems below

the inflorescences and the dense pilose lower surface of the leaves. It seems to me that the long-villose nature of the indumentum on the hypanthium adds a more readily distinguishable character to this distinctive variety. In the typical form of *P. subcanus* Koehne the hairs on the hypanthium are weak, short, and crisp.

43b. **Philadelphus subcanus** var. **magdalenae**, stat. nov.

*Philadelphus magdalenae* Koehne in Mitt. Deutsch. Dendr. Ges. **1904** (13): 83. 1904; **1906** (15): 53. 1906; et in Sargent, Pl. Wils. **1**: 145. 1912. — Vilmorin et Bois, Frutic. Vilmor. 129. 1904. — Schneider, Ill. Handb. Laubh. **1**: 369. 1905. — Silva Tarouca, Freiland-Laubgehölze 283, *fig. 352*. 1913; 256, *fig. 308*. 1930. — Rehder, Man. Cult. Trees Shrubs 274. 1927; ed. 2, 268. 1940; et Bibl. Cult. Trees Shrubs 192. 1949. — Bean in Chitt., Dict. Gard. **3**: 1546. 1951.

TYPE: Vilmorin *7182* (cultivated, seed from Szechuan, China).

Shrub up to 4 m. high, the bark of the second year's growth grayish brown, tardily exfoliate; current year's growth sparsely villose or glabrescent. Leaves ovate, 3–6 cm. long, 1–3 cm. wide, rounded at the base, shortly acuminate or acute at the apex, uniformly pubescent on both surfaces, scabrid or hirsute above, the hairs erect, scabrid-villose beneath, the hairs more or less appressed. Inflorescence 5- up to 11-flowered, racemose or in a few cases paniculate; pedicels, hypanthium and calyx weak-villose, the hairs crisp, the tissue beneath visible; corolla subdisciform, 2 cm. across, the petals glabrous on the back, stamens about 28; style pubescent; capsules obovoid, 10 mm. long, 7 mm. in diameter, the persistent sepals attached a little above the middle; seeds short-caudate, the testa castaneous, the tail slightly shorter than the embryo.

CHINA: Szechuan [Sikang]: Raurong to Ta-chien-lu via Hadjaha, *H. Stevens 150* (A); Ta-chien-lu uplands, *E. H. Wilson 4337* (A), *4387* (A). Yunnan: without precise locality, *E. E. Maire 401* (A); rochers de Pe-long-tsin, *E. E. Maire 3354* (NY, US).

CULTIVATED: Europe: Hort. Vilmorin *2182*, Herb. Dendr. C. Schneider, June 6, 1906 (from TYPE plant, A). United States: Arnold Arboretum *5315–1*, without collector, June 13, 1918 (BH).

*Philadelphus magdalenae* Koehne was established on the basis of a plant cultivated under the number *7182* in the garden of M. L. de Vilmorin, Les Barres, France. The seed was originally collected by Farges in 1894 in Szechuan. It germinated in 1895, and by the time of the publication of the species the type plant was nine years old. Before me there is a specimen collected from that plant on June 2, 1906. It indicates that the plant had not been cared for properly. It is in a declining stage. Most of the flowering twigs were developed from adventitious buds. Consequently the leaves are small and the hairs appear unusually dense. As seen through a binocular, the hairs on the under surface of the leaves are all on the veins and veinlets in the same manner as are the hairs of the under surface of typical *P. subcanus* Koehne. It is the smaller size of the area enclosed

by the reticulations that makes the indumentum appear unusually dense. The inflorescences of this specimen are racemose with some pedicels of the lower flowers tending to branch and to produce cymes in place of single flowers. The petals of this specimen are glabrous. As exhibited in *Wilson 3043*, *4883*, *3042* and *3039*, there is considerable variation in the pubescence on the petals in the typical *P. subcanus* Koehne, from glabrous to evidently golden setose. To me this character is not sufficiently reliable to warrant specific rank, and so it is treated as a variety of *P. subcanus* Koehne with small and uniformly pubescent leaves and glabrous petals.

This variety resembles *P. henryi* var. *cinereus* Hand.-Mazz. in its small, uniformly pubescent leaves, but the latter taxon has a glabrous style and disk.

*E. E. Maire 3354* in the New York Botanical Garden has a pubescent style and disk. It definitely belongs here. But the material deposited in the Arnold Arboretum with identical field notes but no number has a glabrous style and disk. Rehder considered that specimen to be *P. henryi* Koehne, and he was right.

44. **Philadelphus kansuensis** (Rehder), stat. nov.

*Philadelphus pekinensis* var. *kansuensis* Rehder in Jour. Arnold Arb. **9**: 49. 1928; Man. Cult. Trees Shrubs ed. 2, 270. 1940; et Bibl. Cult. Trees Shrubs 193. 1949. — Walker in Contr. U. S. Nat. Herb. **28**: 626. 1941.

TYPE: Kansu, *J. F. Rock 12587* (A).

Upright shrub 2–7 m. high; bark of second year's growth grayish brown, exfoliate, the current year's growth glabrescent or sparsely crisp-villose. Leaves ovate or ovate-lanceolate on the vegetative shoots, up to 11 cm. long, 6.5 cm. wide, on the flowering shoots usually 3–5 cm. long, 1–2 cm., rarely up to 3 cm. wide, subentire or faintly serrate, obtuse or rounded at the base, acuminate at the apex, strigose-villose on the primary nerves and sometimes on the veinlets beneath, rather uniformly setose above, the hairs on both surfaces more or less erect. Inflorescences 5-, 7-, or rarely up to 11-flowered; the rachis 2–8 cm. long, sparsely crisp-villose; pedicels 6–8 mm. long, grayish strigose-villose, the hairs suberect; hypanthium and calyx sparsely strigose-villose, the hairs thickened at the base; sepals ovate-deltoid, 4 mm. long, 3 mm. wide, the apex acute or acuminate; corolla subdisciform, 2.5 cm. across, the petals oblong-suborbicular, 1.2–1.5 cm. long, 1–1.3 cm. wide, sparsely weak-villose at the base on the back; stamens ca. 28, the longest 9 mm. long; disc setose at the rim, otherwise glabrous, the style glabrous, 6–7 mm. long, the upper fifth divided, the stigmas 3 or 4, clavate, the abaxial surface 1 mm. long, the adaxial longer and narrower. Capsules obovoid, 6–8 mm. long, 4–5 mm. in diameter, the persistent sepals subapical. Seeds short-tailed, the embryo 1–1.5 mm. long, the tail one third or one half as long.

CHINA: Kansu: (T'ao River basin) Choni, *J. F. Rock 12587* (TYPE, A), *14926* (A, NY); same locality, *Wm. Purdom 1021* (A); Toyüku, *J. F. Rock*

*12821* (A, US); bank of T'ao, Tebbu, *J. F. Rock 12870* (A, NY), *12883* (A, NY), *12873* (A, US); Ta-tsu-to, Kadjaku Valley, *J. F. Rock 13603* (A); Poyuku, *J. F. Rock 13659* (A), *13687* (A); Lien-hoa Shan, *J. F. Rock 12749* (A); Lower Tebbu, Wan-tsang, *J. F. Rock 14684* (A), *14813* (A), *14852* (A), *15046* (A, US); Mayaku near Nyipa Village, *J. F. Rock 14791* (A, US), *15076* (A); Pezhu, *J. F. Rock 14948* (A); Upper Tebbu, Ping-fan, *R. C. Ching 484* (A, US); Li-chen, *R. C. Ching 325* (A, US), *393* (A, US), *400* (A), *440* (US); Tien-schiu, in via Min-Schemo-Weitseba, *G. Fenzel 2776* (A).

CULTIVATED: Arnold Arboretum *21675* (Rock seed no. *13603*), *E. J. Palmer*, June 11, 1926 (A); *S. Y. Hu*, June 13, 1951 (A); Arnold Arboretum *21701* (Rock seed no. *14948*), *E. J. Palmer*, July 6, 1937 (A).

*Philadelphus kansuensis* is known only from Kansu Province. The type was collected at Choni, where it occurs in forests along the banks of streams at altitudes of 2890 meters. The plant has been recorded as growing on the outskirts of *Picea* and *Abies* forests, mixed with *Juniperus* at altitudes of 2240 to 3050 meters. It is a shrub up to seven meters high, and its white fragrant flowers appear in July. *Rock 14813* was collected in September and was still in flower.

Rehder interpreted this taxon as a variety of *P. pekinensis* Rupr. because of its general appearance, which resembles that of the latter species. This resemblance is rather superficial. The erect pubescence on the upper surface of the leaves, the villose stems, and the setose rim of the disc are not found in *P. pekinensis*. They suggest a closer relationship with *P. subcanus* Koehne. The hairs on the hypanthium are strigose-villose, resembling *P. sericanthus* Koehne. Thus morphologically *P. kansuensis* represents an ensemble of the traits of *P. pekinensis*, *P. subcanus*, and *P. sericanthus*. Geographically its range illustrates a very interesting principle for the understanding of the phytogeography of China. This species occurs only in southern Kansu, at the northern portion of Min-shan, which constitutes the western end of the Tsingling Range. At that place not only do the tributaries of the Yellow River have their source, flowing to the north, and those of the Yangtze River originate and flow to the south, but the point is also the junction of the mountains that constitute the backbones of northwestern, western, and central China. Northeastward from Min-shan runs the Tai-hang-shan Range, on which occurs *P. pekinensis*. Eastward is the Tsingling proper, where *P. sericanthus* occurs. Southeastward runs the north-south line of the Szechuan Alps, where *P. subcanus* is found. Thus the western portion of Tsingling, the Min-shan, forms a bridge to join the floras characteristic of North and West China. *Philadelphus kansuensis* certainly proves this.

Rock in 1926 sent seed lot *13603* to the Arnold Arboretum, and the seeds germinated in September 1929. The cultivated plants go under the number *13603*. His seed lot *14948* reached the Arnold Arboretum in 1927. The Arboretum number of the plants raised from these seeds is *21701*.

45. **Philadelphus schrenkii** Rupr. in Bull. Phys.-Math. Acad. Sci. St. Pétersb. **15**: 365. 1857; et in Mél. Biol. **2**: 542. 1858. — Koehne,

Deutsche Dendr. 182. 1893; in Gartenfl. **45**: 596. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904** (13): 84. 1904. — Komarov in Act. Hort. Petrop. **22**: 429. 1903. — Maxim. Prim. Fl. Amur. 109. 1859. — Schneider, Ill. Handb. Laubh. **1**: 372, *fig. 237, w–w*$^2$. 1905. — Smith in Jour. Linn. Soc. Bot. **36**: 500. 1905. — Nakai, Chosen Shokubutsu **1**: 336, *fig. 414*. 1914; in Bot. Mag. Tokyo **29**: 65. 1915; et Fl. Sylv. Kor. **15**: 53, *pl. 12*. 1926. — Nekrasowa Fl. As. Russ. I. **3**: 8. 1924. — Minami, List Pl. Manch. Mong. 183. 1926. — Rehder, Man. Cult. Trees Shrubs 276. 1927; ed. 2, 271. 1940; et Bibl. Cult. Trees Shrubs 193. 1949. — Poiarkova in Komarov, Fl. SSSR **9**: 222. 1939. — Makino & Tanaka, Man. Fl. Nipp. 229. 1927. — Murakoski, Daizukan **7**: 23. 1935. — Chen, Ill. Man. Chin. Trees Shrubs 374. 1937. — Kitagawa, Lineam. Fl. Mansh. 253. 1939. — Sato, Ill. Manch. Mong. Trees ed. 2, 129, *fig. 91*. 1943. — Bean, Trees Shrubs ed. 7, **2**: 419. 1950; et in Chitt. Dict. Gard. **3**: 1546. 1951.

*Philadelphus coronarius* Linn. γ *satsumi* Maxim. in Mém. Acad. Sci. St. Pétersb. Sér. VII. **10** (16): 40 (Rev. Hydrang. As. Or.). 1867, pro parte.

*Philadelphus satzumi* var. *schrenkii* Lavallée, Arb. Segrez. Enum. 115. 1877, *nom. nud.*

*Philadelphus schrenkii* f. *canescens* Komarov in Bull. Jard. Bot. Russe **16**: 173. 1916.

*Philadelphus tenuifolius* var. *schrenkii* Vassiljev in Not. System. **8** (12): 219. 1940.

*Philadelphus schrenkii* f. *longipedicellatus* Nakai in Jour. Jap. Bot. **19**: 374. 1943.

TYPE: *Schrenk*, Amur River.

An upright shrub 2–4 m. high, bark of two-year-old twigs gray, closed, smooth and longitudinally rimulose, rarely brownish gray with transverse cracks and tardily exfoliate, the current year's growth hirsute often becoming glabrescent, the hairs compressed. Leaves ovate, rarely ovate-elliptic, those on the vegetative shoot 7–13 cm. long, 4–7 cm. wide, those on the flowering shoot 4.5–7.5 cm. long, 1.5–4 cm. wide, obtuse or acute at the base, acuminate at the apex, remotely denticulate or subentire, very sparsely villose on the primary nerves beneath, glabrous or rarely sparsely pilose above. Flowers very fragrant, 5 or 7 (rarely 3) in a determinate raceme; the pedicels 6–13 mm. long, densely villose; hypanthium pilose, the sepals ovate, 4–7 mm. long, glabrous or glabrescent; corolla 2.5–3.5, very rarely up to 4 cm. across, the petals oblong-obovate, 1.5–1.8 cm. long, 1–1.2 cm. wide; stamens 25 up to 30; style half or more divided, hirtellous, the disk glabrous, the stigmata clavate, the abaxial stigmatic surface half the length of or subequal to the adaxial surface, and broader than the latter. Capsules ellipsoid, pointed at the apex, 6–9 mm. long, 4–5 mm. in diameter, the persistent sepals supermedian. Seeds short-tailed.

ASIA: Eastern Siberia and Manchuria: Er Tieng Tien Tse, *P. H. & J. H. Dorsett 3059* (US); Amur, *S. Korshinsky* in 1891 (US); *C. S.*

*Sargent*, Aug. 22, 1903 (A); *B. V. Skvortzov*, June 21, 1938 (A); *R. Maak 43* (G), *Maximowicz* (G). Korea: *K. S. Gilbert 32* (A), *46* (A), *59* (A); Pyengyang, *R. K. Smith*, May 12, 1934 (A); N. Kankyo, *E. H. Wilson 8921* (A); Kogen, *E. H. Wilson 10430* (US), *10514* (A, US); N. Heian, *E. H. Wilson 10682* (A); Chiisan, Keisyonando, *K. Uno 23252* (A).

CULTIVATED: United States: Arnold Arboretum, without collector, June 15, 1881, plant from St. Petersburg (A); *1047–37, S. Y. Hu*, May 24, 1951 (A); *19356, S. Y. Hu*, June 14, 1951 (A); State College, Pa., *R. P. Meahl*, June 1937; U. S. Dept. Agric. *72411*, seeds obtained by P. H. Dorsett, collected in the Forest Concession of the Chinese Eastern Railway in the vicinity of Shitoukhetsy by *I. V. Kosloff*, Harbin (A).

Because of its hairy style *P. schrenkii* has created little confusion in botanical literature. Maximowicz interpreted it as being conspecific with the Japanese *P. satsumi* and placed them both in a variety of *P. coronarius*. In this he erred, for the Japanese taxon has a more or less glabrous hypanthium, and when hairs are present they are short and curly. Poiarkova in Komarov's Fl. SSSR, suggested that *P. schrenkii* has larger and more fragrant flowers than *P. tenuifolius*. Vassiljev took this suggestion and actually made the trinomial *P. tenuifolius* var. *schrenkii*, limiting it to plants producing flowers 3.5–4 cm. in diameter. As the size of the flower in all the species of *Philadelphus* varies considerably in relation to the vigor of the plant, the age of certain shoots, environmental conditions, and even the position of the individual flowers, flower size alone should not be used to delimit taxa. Our material seems to indicate that flowers 3.5–4 cm. in diameter are extremes rather than means. Thus U. S. Dept. Agric. *72411* bears flowers 3–4 cm. in diameter in Maryland, 2.5 cm. in Pennsylvania, and even smaller in California. Most of the flowers of the Maryland-grown plant are between 3 and 3.5 cm. in diameter, and only a few located in the center of the inflorescences are up to 4 cm. in diameter. Although the flower sizes in various plants of this number differ, their appearance, the shape of the petals, the indumentum on the pedicels and hypanthium as well as the hairs of the style are the same. In material from feral plants examined the condition is the same. I therefore cannot accept Vassiljev's conclusion. The pubescent style of *P. schrenkii* is a constant character. There is no indication that this character is a non-inheritable modification. Until our knowledge of the cytology of the closely allied species is fully understood, it is best to retain it as a distinct species.

*Philadelphus schrenkii* is closely related to *P. tenuifolius*. In other than the hairy style character of the former, there is little difference between them, either geographically or morphologically. The fruit shape and the position of the persistent calyx seem to provide some concomitant distinguishing characters. In *P. schrenkii* the fruits are ellipsoid, attenuate at both ends, with the calyx attached two thirds towards the distal end, while in *P. tenuifolius* the fruits are obconical, rounded at the distal end, the calyx nearly apical.

The natural range of distribution of *P. schrenkii* is eastern Siberia, Manchuria, and Korea. There it is a shrub about two meters high, common or

even abundant at altitudes from sea level to 1500 meters elevation. It flowers in late June and early July. Makino and Tanaka reported it as occurring in Japan, but it is suspected that it may have been introduced there.

45a. **Philadelphus schrenkii** var. **jackii** Koehne in Fedde, Rep. Spec. Nov. **10**: 127. 1911. — Rehder, Man. Cult. Trees Shrubs 277. 1927; ed. 2, 271. 1940; et Bibl. Cult. Trees Shrubs 193. 1949. — Chen, Ill. Man. Chin. Trees Shrubs 374. 1937. — Bean in Chitt. Dict. Gard. **3**: 1546. 1951.

*Philadelphus lasiogynus* Nakai in Bot. Mag. Tokyo **29**: 67. 1915.

*Philadelphus schrenkii* sensu Nakai in Bot. Mag. Tokyo **29**: 65. 1915, non Rupr. 1857.

Leaves on the flowering twigs ovate-elliptic, rarely ovate, 3.5–7 cm. long, 1.5–3.5 cm. wide, very sparsely pilose on both surfaces, especially on the primary nerves beneath, or glabrescent, remotely serrate, acute or obtuse at the base, shortly acuminate at the apex; flowers very fragrant, 5–7 in a raceme, the corolla 2.5–3.5 cm. in diameter, the petals oblong-obovate, 1–1.5 cm. long, 0.7–1 cm. wide, the stamens 25–35, the styles pubescent, the disk ± pubescent.

MANCHURIA: Kirin, *F. H. Chen 407* (A); *B. A. Irashkerich 427* (A); Shitokheza, *D. Litvitvinov 2058* (A), *2852* (A); Swuifenho, *B. V. Skwortzov* on June 10, 1925 (A); Sieho, *B. V. Skwortzov* on Aug. 1, 1925; *V. Komarov 833, 834* (A).

KOREA: N. Heian, French Mine, *E. H. Wilson 8638A* (A); N. Kankyo, Tumen-Yalu divide, *E. H. Wilson 9075* (A); Hohari, *Furumi*, July 1, 1917 (A).

CULTIVATED: Arnold Arboretum *6595*, from seed collected in Korea by *J. G. Jack* in 1905, *A. Rehder*, June 4, 1910 (TYPE, A), May 30, 1911 (A), June 3, 1912 (A); *S. Y. Hu*, June 14, 1951 (A); *423–39*, grown from seed received from the Acad. Sci. USSR., *S. Y. Hu*, June 14, 1951 (A); Hort. H. H. Hunnewell, Wellesley, *A. Rehder*, June 14, 1899 (A).

The original species was dedicated to A. G. von Schrenk. Koehne in publishing the variety used the erroneous spelling *schrenckii*, and Nakai, who probably did not check the original publication, followed him.

The variety was based on a plant cultivated in the Arnold Arboretum. The characters that Koehne emphasized hold for the cultivated plants after more than forty years. Although specimens collected in 1951 have smaller and fewer flowers, the indumentum, the style and the disk are identical with those of specimens collected in 1910. Specimens from feral plants that possess a hairy disk seem to be more or less glabrous. In this respect they more closely resemble typical *P. schrenkii* than *P. schrenkii* var. *jackii*. These specimens also exhibit a gradual change in the density of the disk pubescence from barely evident to partially pubescent to rather densely pubescent. Apparently the disk indumentum is variable. Nakai, without examining Koehne's type, treated *P. schrenkii* var. *jackii* as a synonym of *P. schrenkii*, and described the Korean *P. lasiogynus* as

a new species, characterized by having a pubescent disk. I see no reason for distinguishing this from Koehne's variety.

In the living *Philadelphus* collection at the Arnold Arboretum, no. *423–39* is a species under an apparently unpublished binomial, the species being dedicated to Rafinesque. This was raised from seeds obtained from the Academy of Science, U.S.S.R. But it is typical *P. schrenkii* var. *jackii* in all respects, even to the hairs on the lower surface of the leaves. At the Arnold Arboretum it flowers in mid-June. The flowers are white and fragrant, with the petals narrowly tinged red on the back along the median line, and the sepals are pale yellowish green.

45b. **Philadelphus schrenkii** var. **mandshuricus** (Maxim.) Kitagawa, Lineam. Fl. Mansh. 253. 1939.

*Philadelphus coronarius* var. *mandshuricus* Maxim. in Mém. Acad. Sci. St. Pétersb. Ser. VII. **10** (16): 41 (Rev. Hydrang. As. Or.). 1867.

*Philadelphus mandshuricus* (Maxim.) Nakai in Bot. Mag. Tokyo **29:** 66. 1915. — Nekrasowa, Fl. As. Russ. I. **3:** 7. 1924, as "manshuricus."

*Philadelphus amurensis* Komarov in Bull. Jard. Bot. Russe **16:** 170. 1916.

*Philadelphus schrenkii* sensu Rehder, Man. Cult. Trees Shrubs 277. 1927; ed. 2, 271. 1940; et Bibl. Cult. Trees Shrubs 193. 1949, pro parte, in syn., non Ruprecht.

Leaves broadly ovate, up to 8 cm. long, 5 cm. wide, rounded or obtuse at the base, the apex shortly acuminate, the margin finely but remotely serrate; flowers 5 or 7, 3–3.5 cm. in diameter, the hypanthium sparsely hirsute, the petals suborbicular, 1.2–1.5 cm. in diameter, the style pubescent, the disk ± pubescent.

MANCHURIA: Mandshuria austro-orientalis, St. Olga, *Maximowicz*, June 21, 1860 (ISOTYPE of *P. coronarius* var. *mandshuricus* Maxim., G, US).

CULTIVATED: Arnold Arboretum *534* under an unpublished trinomial.

Maximowicz characterized this as having large, inodorous or disagreeably odorous flowers, its petals subrotundate. Nakai treated this taxon as a species but gave no reason for this; his concept was adopted by Nekrasowa. Judging from their keys, both assumed the plant to have a glabrous style, and they overlooked the petal characters that Maximowicz employed to distinguish the variety. With an isotype before me, I believe that Kitagawa was correct in transferring it to *P. schrenkii* as a variety.

46. **Philadelphus hupehensis** (Koehne), stat. nov.

*Philadelphus incanus* var. *sargentianus* forma *hupehensis* Koehne in Fedde, Repert. Sp. Nov. **10:** 127. 1911; et in Sarg., Pl. Wils. **1:** 145. 1912.

TYPE: *E. H. Wilson*, Veitch Exp. *833* (A).

A shrub, the branches gray, the bark of the second year's growth closed, longitudinally rimulose, the current year's growth villose. Leaves elliptic, 7–10 cm. long, 2.5–5 cm. wide, acute, rarely obtuse at the base, acuminate

at the apex, sharp-serrate, uniformly hirsute above, the hair erect, compressed at the base, sparsely strigose on the principal nerves and veinlets beneath. Inflorescence 9-, 13-, 19-, or 7-flowered; pedicels dense-strigose and incanous, the lower pairs sometimes branched, each carrying a cyme of 3 flowers; hypanthium and calyx strigose, more or less incanous, the sepals ovate, 6 mm. long, 3 mm. wide at the base; corolla disciform, 1.5–2 cm. across, the petals obovate-suborbicular, 10 mm. in diameter, sparsely pilose at the base of the back; stamens ca. 35, disc and style pilose, the pubescence straight; the style 4 mm. long, undivided, the stigmata spatulate. Capsules subglobose-ovoid, 9 mm. long, 8 mm. in diameter, the persistent sepals subapical. Seed short- or medium-caudate, the embryo 1.25 mm. long, the tail half as long, the testa brown.

CHINA: Hupei: Fang Hsien, *E. H. Wilson 581* (A, G); without precise locality, possibly Ichang, *E. H. Wilson*, Veitch Exp. *833* (A, TYPE); Wan-tsao Shan, *W. Y. Chun 3918* (A). Shensi: Kiu San, *Jos. Giraldi* in 1897 (A); Kiu-gua San, *Jos. Giraldi*, July 10, 1897 (A). Yunnan: Suen-oui, *E. E. Maire 403* (A); Yong-shan Hsien, *H. T. Tsai 51182* (A).

The density of the hairs on the lower leaf surface of this species indicates an intermediate position between *P. incanus* and *P. sericanthus*. The erect hairs on the upper surface of the leaves and the white indumentum on the hypanthium suggest a closer relationship with *P. incanus* than with *P. sericanthus*. On the strength of these characters Koehne was right in placing it as a variety of the former species. Nevertheless, he overlooked the presence of hairs on the style, a character never found in *P. incanus*. Within this series *P. subcanus* and *P. schrenkii* are the species that have pubescent styles. The type of the indumentum and the total appearance of this species are different from those characters in *P. subcanus*. *Philadelphus schrenkii* is a species from Manchuria and Korea. Besides the morphological differences that exist between the present species and *P. schrenkii*, there is also the geographical separation. After considering every possible alliance, I find it necessary to raise the status of this taxon from that given it by Koehne.

### Series 8. **Satsumani** (Koehne), stat. nov.

**Philadelphus** subg. II. **Euphiladelphus** sect. 4. **Stenostigma** ser. 8. **Satsumani** (Koehne), stat. nov.

*Philadelphus* sect. *Stenostigma* subsect. *Satsumani* Koehne in Gartenfl. **45**: 450. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904** (13): 82, 84. 1904.

*Philadelphus* sect. *Satsumani* (Koehne) Nakai in Bot. Mag. Tokyo **29**: 64. 1915; et in Jour. Jap. Bot. **19**: 371. 1943.

*Philadelphus* sect. *Coronarii* (Koehne) Nakai, l.c., pro parte.

*Philadelphus* ser. *Coronarii* (Koehne) Rehder, Man. Cult. Trees Shrubs ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1949, pro parte.

TYPE SPECIES: *P. satsumanus* Sieb. ex Miq.

Medium-sized upright shrubs, the bark closed; leaves ovate or ovate-

elliptic, caudate or acuminate at the apex; inflorescences 7-, 5-, rarely 3-flowered, the hypanthium sparsely pubescent or only on the angles, the hairs golden, curly; corollas generally small, 2–3 cm. across; stamens 23–30; abaxial stigmatic surface broad, equal to or half the length of the adaxial surface; capsules ovoid or ellipsoid; seeds medium-caudate.

KEY TO THE SPECIES

A. Style glabrous.
  B. Leaves uniformly pubescent ..... 47. *P. satsumanus.*
  BB. Leaves glabrous except on the primary nerves and in their angles beneath. ..... 48. *P. satsumi.*
AA. Style pubescent; leaves glabrous above, glabrous except the primary nerves and their angles beneath. ..... 49. *P. shikokianus.*

47. **Philadelphus satsumanus** Sieb. ex Miq. in Ann. Mus. Bot. Lugd.-Bat. **3**: 99. 1867. — Rehder in Mitt. Deutsch. Dendr. Ges. **1910** (19): 249. 1910; Man. Cult. Trees Shrubs 275. 1927; ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1949, pro parte. — Engler, Pflanzenf. ed. 2, **18a**: 194. 1930, pro parte.

*Philadelphus coronarius* var. *satsumanus* Jäger, Zierzchöltz ed. 2. 236. 1884.

*Philadelphus matsumuranus* Koehne in Gartenfl. **45**: 619. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904** (13): 86. 1904. — Schneider, Ill. Handb. Laubh. **1**: 374. 1905. — Makino & Tanaka, Man. Fl. Nipp. 228. 1927.

*Philadelphus satsumanus* var. *nikoensis* Rehd. in Mitt. Deutsch. Dendr. Ges. **1910** (19): 249. 1910; Man. Cult. Trees Shrubs 275. 1927; ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1940.

*Philadelphus satsumi* sensu Nakai in Bot. Mag. Tokyo **29**: 64. 1915, pro parte, non Sieb. ex Lindl. & Paxt.

*Philadelphus gordonianus* var. *parviflorus* Dippel, Handb. Laubh. **3**: 343. 1893.

*Philadelphus yokohama* Dippel, l.c., non Lavallée, 1877.

*Philadelphus satsumi* var. *yokohama* Dippel, l.c., in syn.

TYPE: *Siebold* (Mus. Bot. Lugd.-Bat., Leyden).

An upright shrub 1.5–2.5 m. high, bark of the two-year-old twigs castaneous, closed, longitudinally rimous, rarely brown and tardily exfoliate; current year's growth pubescent or glabrescent. Leaves uniformly and sparsely pilose above, tomentose beneath; those on the vegetative shoots ovate, rarely ovate-elliptic, 5–10 cm. long, 2.5–6 cm. wide, rounded, rarely obtuse at the base, caudate, rarely acuminate at the apex; those on the flowering shoots ovate, rarely elliptic, 3–7 cm. long, 1–3.5 cm. wide, obtuse, rarely rounded at the base, acuminate at the apex, remotely and finely serrate. Flowers 5 or 7 in a raceme, the lower pairs in the axils of normal leaves; the pedicels 4–6 mm. long, pilose, the hypanthium pilose along the nerves or all over; sepals ovate, 4 mm. long, often pilose; corolla 2.5–3 cm. across, rarely smaller, the petals oblong-ovate, 1–1.4 cm. long, 0.7–1 cm. wide; stamens 25–30; styles glabrous, entire or slightly divided, the adaxial stigmatic surface equal to or slightly shorter than the

abaxial. Capsule obovoid, the persistent sepals attached one fourth below the apex. Seeds medium-caudate.

JAPAN: Hondo: Asama, *U. Faurie 6264* (A); Shinano, *J. G. Jack*, Sept. 3, 1905 (A); same locality, *S. Okuyama* on July 2, 1949 (BH, fragment in A); Musashi, U. S. Dept. Agric., May 19, 1911 (US); same locality, *M. Mizushima 2020* (A), *2587* (A); Kai Kofu, *K. Sakurai*, June 9, 1910 (A); Nikko, *N. Mochizuki*, Aug. 30, 1909 (A, G); same locality, *J. A. Veitch*, Oct. 18, 1892 (A, TYPE of *P. satsumanus* var. *nikoensis* Rehder); Mino, *K. Shiota 1326* (A), *8919* (A); Ontakesan, *G. Koizumi*, Aug. 1910 (BH); Uraminotaki, *T. Sawada 2194* (A); Tokyo, *S. Suzuki 289* (A); Mt. Ominein Yamato, *H. Tanaka*, July 17, 1933 (C); Nitromine-san, *E. H. Wilson 6964* (A); Utake-gawa, *E. H. Wilson 9661* (A, US); Kozuke, *M. Mizushima 1267* (A), *1869* (A); Shimotsuke, *M. Mizushima 2124* (A), *2299* (A), *2351* (A).

CULTIVATED: Europe: Germany: Hort. Götting, *A. Rehder*, July 1, 1890 (A). Austria: H. Braun, June 18, 1907 (A). United States: Arnold Arboretum 1580–4, without collector, Sept. 21, 1897 (A), June 19, 1899 (A); *5097*, without collector, June 13, 1914 (A), June 21, 1916 (A).

Both morphologically and ecologically this species is very closely allied to *P. satsumi* Sieb. ex Lindl. & Paxt., yet the tomentose lower leaf surface is distinctive. In general the hypanthia of this species are more pubescent than those of *P. satsumi*. Nevertheless, there seems to be much variation in the density of the pubescence on the hypanthia of this species. A few of the specimens that I have examined even have subglabrous ones.

48. **Philadelphus satsumi** Sieb. ex Lindl. & Paxt. in Fl. Gard. 2: 102, *fig. 188*. 1852. — Koch, Dendr. 1: 338. 1869. — Nicholson, Ill. Dict. Gard. 3: 95. 1886. — Koehne, Deutsche Dendr. 180. 1893; in Gartenfl. **45**: 562. 1896; et in Mitt. Deutsch. Dendr. Ges. **1904** (13): 84. 1904. — Schneider, Ill. Handb. Laubh. 1: 371, *fig. 237, f–h*. 1905. — Nemato, Nippon Shokubutsu soran hoi (Fl. Jap. Suppl.) 295. 1936. — Makino, Ill. Fl. Nipp. 487, *fig. 1461*. 1940.

*Philadelphus coronarius* var. *satsumi* Maxim. in Mém. Acad. Sci. St. Pétersb. Sér. VII **10** (16): 40 (Rev. Hydrang. As. Or.) 1867, excl. syn. — Dippel, Handb. Laubh. **3**: 337. 1893. — Makino & Tanaka, Man. Fl. Nipp. 228. 1927. — Makino & Nemato, Nippon Shokubutsu soran 443. 1933. — Terasaki, Nippon Shokubutsu zufu, *pl. 388*. 1933. — Murakoshi, Dai-zukan **7**: 23, *fig. 47*. 1935. — Kia, Pl. Sin. Ill. 702, *fig. 1217*. 1937.

*Philadelphus chinensis* Hort. ex Koch, Dendr. 1: 339. 1869. — Nicholson, Ill. Dict. Gard. 3: 95. 1886.

*Philadelphus satsumanus* sensu Koch, Dendr. 1: 339. 1869. — sensu Rehder in Mitt. Deutsch. Dendr. Ges. **1910** (19): 249. 1910; Man. Cult. Trees Shrubs 275. 1927; ed. 2, 269. 1940; et Bibl. Cult. Trees Shrubs 192. 1949. — sensu Bean, Trees Shrubs ed. 7, **2**: 419. 1950, non Sieb. ex Miq. 1867.

*Philadelphus nepalensis* Hort. ex Koch, Dendr. 1: 339. 1869.

*Philadelphus roylei* Hort. ex Koch, l.c. — Nicholson, Kew Hand-list 1: 227. 1894, 377. 1902.

*Philadelphus speciosus* sensu Koch, l.c. — Nicholson, l.c., non Schrader. 1828.

*Philadelphus ledebourii* Hort. ex Koch, l.c. — Nicholson, l.c.

*Philadelphus pekinensis* sensu Koch, l.c., non Rupr. 1857.

*Philadelphus schrenkii* sensu Maxim. in Mém. Acad. Sci. St. Pétersb. Sér. VII. **10** (16): 40 (Rev. Hydrang. As. Or.) 1867, pro parte. — sensu Koch, l.c., pro parte, non Rupr. 1857.

*Deutzia japonica* Hort. ex Koch, l.c. — Nicholson, l.c.

*Deutzia pulchella* Hort. ex Koch, l.c. — Nicholson, l.c.

*Deutzia undulata* Hort. ex Koch, l.c.

*Deutzia sanguinea* Hort. ex Koch, l.c.

*Deutzia gracilis* Hort. ex Koch, l.c., non Sieb. & Zucc. 1835.

*Deutzia thyrsiflora* Hort. ex Koch, l.c.

*Deutzia corymbosa* Hort. ex Koch, l.c., non R. Brown, 1835.

*Philadelphus acuminatus* Lange in Fortegn. Veter.-Landboh. Frilandstr. 65. 1871; et in Bot. Tidskr. III. **2**: 131, *pl. 2*. 1878. — Schneider, Ill. Handb. Laubh. **1**: 371. 1905.

*Philadelphus japonicus* Hort. ex Nicholson, Kew Hand-list **1**: 227. 1894; et ed. 2. 377. 1902.

*Philadelphus pulchellus* Hort. ex Nicholson, ll.cc.

*Philadelphus coronarius* var. *acuminatus* (Lange) A. H. Moore in Rhodora **17**: 122. 1915.

*Philadelphus satsumi* var. *nikoensis* Nemato, Nippon Shokubutsu soran hoi (Fl. Jap. Suppl.) 295. 1936.

Type: *Siebold* (Roy. Hort. Soc. Gard., Wisley).

An upright shrub 1.5–3 m. high, the bark of the two-year-old twigs brown, closed and longitudinally rimulose, tardily exfoliate; current year's growth slender, glabrescent. Leaves very sparsely setose or glabrous above, hirsute on the primary nerves and bearded in their angles beneath; those on the vegetative shoots ovate or broadly elliptic, 6–9 cm. long, 3–5 cm. wide, remotely and coarsely serrate, obtuse or rarely rounded at the base, acuminate or caudate at the apex, the acumen up to 2 cm. long; those on the flowering twigs ovate or ovate-lanceolate, 4.5–7 cm. long, 1.5–4.5 cm. wide, acute or obtuse or very rarely rounded at the base, acuminate or caudate at the apex. Flowers slightly fragrant, 5 or 7 in a raceme, rarely 2 or 3 terminating the branchlet, the pedicels 6–8 mm. long, pilose; hypanthium pilose at the angles or on the nerves, otherwise glabrous, the hairs short, curly, and golden, the sepals ovate, 6 mm. long; corolla 3 cm. across, the petals oblong-obovate or ovate, 1.3–1.5 cm. long, 0.9–1 cm. wide; stamens 30; style glabrous, shortly divided at the apical end, the abaxial stigmatic surface equal to or slightly shorter than and twice as broad as the adaxial surface. Capsules ellipsoid, attenuated at both ends, more so at the base. Seeds medium-caudate.

JAPAN: Near Shojiko, Fujiyama region, *P. H. Dorsett & W. J. Morse 383* (US); Musashi, *H. Ito 190* (BH); Shinano, *J. G. Jack*, Sept. 4, 1905 (A); same locality, *M. Mizushima 2223* (A); Hida, *K. Shiota 6741* (A); Senano, *Tschonoski* in 1864 (G, US); Nambu, *Tschonoski* in 1865 (G, US); Idzu, *Tschonoski* in

1866 (US); Nanokawa, Tosa, *K. Walanabe*, June 14 1889 (G); Hayachima-san, *E. H. Wilson 7563* (A); Hakone, *E. H. Wilson 10364* (A); Naganoken, *K. Uno*, Aug. 28, 1951 (A); Kanagaloa, *S. Suzuki*, June 4, 1951 (A).

CULTIVATED: Europe: Kew, *G. Nicholson*, June 16, 1880 (A), Sept. 28, 1882 (A); *Macklean 381* (B); Hort. Bot. Berol., *E. Koehne 363* (A, G); Hort. Späth, *C. Schneider*, June 27, 1902 (A); Hort. Götting, *A. Rehder*, July 1, 1890 (A), June 17, 1894 (A). United States: Arnold Arboretum *15414* (A).

Among the earlier known species of *Philadelphus* this one has caused the most confusion in botanical literature. To clarify the confusion, the following data must be considered: (1) *Philadelphus satsumi* Sieb. ex Lindl. & Paxt. was the first binomial assigned to this Japanese *Philadelphus*. (2) Siebold, as a result of his voyage to Japan, introduced living specimens to Europe and provided Zuccarini with herbarium material. Both living and dry material had reached Lindley and Paxton before 1852, when they prepared a very inadequate illustration and description of *P. satsumi* Sieb. The flowering branches of their living material, from which the illustration was made, bore only two or three flowers. Yet they compared their living form with a Japanese specimen provided by Professor Zuccarini. Consequently, regarding the number of flowers of the species they remarked, "They . . . appear hereafter in long interrupted racemes with linear or almost filiform bracts. The calyx is smooth." As to the leaves, they stated that the foliage was slightly hairy on the under side, the lower leaves ovate-lanceolate, acuminate, and with a few shallow very acute serratures. (3) The Siebold Company published a nursery catalogue in 1856, in which, on page 337, *P. satsumanus* appeared as a *nomen nudum*. (4) Miquel in 1867 described this catalogue entry, *P. satsumanus* Sieb., as having its calyx tube densely pubescent, and its broadly ovate or elliptic leaves sparsely puberulent above and on the reticulations beneath. (5) Koch in 1869 extended the range of the species to China and the Himalayan region and thus created many synonyms. (6) Maximowicz in 1867 considered the Japanese species identical with *P. schrenkii* of Manchuria and combined them, making a variety of *P. coronarius*. (7) Koehne in 1893 interpreted *P. satsumi* Sieb. ex Lindl. & Paxt. as conspecific with *P. laxus* Schrader and redescribed *P. satsumi* on the basis of a specimen cultivated in the Berlin Botanical Garden. He characterized it as having a glabrous hypanthium and calyx, or only the hypanthium somewhat hairy; the lower surface of the leaves glabrous or only slightly hairy on the reticulations; and the raceme with seven flowers. (8) Rehder in 1910, 1927, 1940 and 1949 accepted Koehne's concept of the species. As he considered *P. satsumi* Siebold a preoccupied name, he adopted Miquel's binomial for the form described by Koehne and ascribed to *P. satsumanus* var. *nikoensis* the form represented by the Japanese *Philadelphus* having its leaves pubescent beneath. (9) Nemato reduced Rehder's variety to *P. satsumi* Sieb. ex Lindl. & Paxt. and accidentally published the trinomial *P. satsumi* var. *nikoensis* Nemato.

The feral Japanese material that I have examined contains two distinct

elements, one with an almost glabrous hypanthium, pubescent with short curly golden hairs only at the base or on the angles. The leaves of this element are usually glabrous beneath except on the primary nerves and in their axils. The other element has a uniformly pubescent hypanthium and the lower leaf-surface is pubescent throughout. Specimens from cultivated plants at Kew, Berlin, and the Arnold Arboretum show both characters. It is most likely that in the Siebold introduction both elements were involved. What Lindley and Paxton described was the glabrous one, and what Miquel described was the more pubescent one.

A comparative study of the Japanese specimens and the continental forms, including collections cited by Maximowicz, indicates that several distinct species are represented. The Japanese species differs from the mainland forms in the short golden curly pubescence on the ridges or all over the hypanthium, in the broader and longer abaxial stigmatic surfaces, and in the medium or long-tailed seeds. Maximowicz' interpretation of the Japanese and Manchurian species as identical is not justified morphologically.

Lindley and Paxton worked in London. Specimens collected from plants cultivated at Kew 1880–1890 agree with the spontaneous Japanese specimens in the outline of the leaves, the indumentum, in the size of the flowers, the shape of the petals, the length and division of the styles, the width of the stigmatic surfaces, and the tails of the seeds. These specimens may represent descendants of the form that Lindley and Paxton described. In all respects they are identical with *Koehne 363*, the basis of the latter's description of *P. satsumi* Sieb. Thus specimens from plants cultivated in England and Germany prove the two taxa to represent one and the same species. The only character that might lead one to doubt the identity of Lindley and Paxton's species and that of Koehne is the number of flowers on a flowering twig, the former having two or three flowers, while in the latter the inflorescence is usually seven-flowered. But this difference occurs also in nature. Most of our Japanese material has five or seven flowers on a twig, but Jack's Shinano specimen bears only two or three flowers. In this case the material was collected from a very old plant. The flowering twigs are apparently developed from lateral accessory buds. Very likely Lindley and Paxton's living material was somewhat anomalous, as is often the case when a recently planted specimen first flowers. They did, however, explain that the herbarium specimen sent by Zuccarini had an inflorescence in the form of a long interrupted raceme. Miquel's description represents a distinct but closely related species with uniformly pubescent lower leaf surfaces.

Judging from Lange's description and illustration, his *P. acuminatus* is identical with *P. satsumi* Sieb. ex Lindl. & Paxt. A. H. Moore proposed *P. coronarius* var. *acuminatus* on the basis of *P. satsumi*. Naturally it becomes a synonym here.

In Japan *P. satsumi* occurs at altitudes between 600 and 1000 meters. It is common along the roadsides, in woods or thickets, especially on the lava beds.

Maximowicz in 1867 cited *Wilford 1859* from Tsusima Island as belonging here. Koehne in 1896 and Engler in 1930 both recorded it from the same island. The Wilford material in the Gray Herbarium is definitely *P. tenuifolius* Rupr. ex Maxim. I have seen no spontaneous material other than that from Hondo of Japan.

49. **Philadelphus shikokianus** Nakai in Bot. Mag. Tokyo **29**: 66. 1915. — Murakoshi, Dai-zukan **7**: 23. 1935. — Nemato, Nipp. Shok. soran hoi (Fl: Jap. Suppl.) 295. 1936.

*Philadelphus yokohama* Sieb. ex Lavallée, Arb. Segrez. Enum. 115. 1877. — Nicholson, Kew Hand-list **1**: 227. 1894. *nom. nud.*

*Philadelphus sinensis* Hort. ex Lavallée, Arb. Segrez. Enum. 115. 1877, *nom. nud.*

TYPE: *T. Makino*, June 14, 1889 (Japan).

An upright shrub, branchlets slender, bark of two-year-old twigs brown, closed or tardily exfoliate, the current year's growth 1–2 mm. in diameter, pubescent. Leaves glabrous or along the margin sparsely hirtellous above, glabrous beneath except on the nerves and in their angles; those on the vegetative shoots ovate or broadly elliptic, 8–10 cm. long, 3.5–6 cm. wide, acute or rounded at the base, caudate at the apex, remotely serrate; those on the flowering twigs lanceolate or ovate, 4–8 cm. long, 1.5–3.5 cm. wide, acute or rounded at the base, acuminate at the apex, remotely and finely serrate. Inflorescence 5- or 7- or rarely 9-flowered, the lowest pair in the axils of normal leaves, the pedicels 8–12 mm. long, pilose; hypanthium uniformly pubescent, the calyx lobes ovate, acuminate, pubescent, 4–7 mm. long; corolla 2–2.5 cm. across, the petals oblong, 8–12 mm. long, 6–8 mm. wide; stamens 19–23; disk and style pubescent, the style slightly divided, the abaxial stigmatic surface short and broad, half the length of the adaxial. Capsules obovoid, the persistent sepals attached one third below the apex. Seeds medium-caudate.

JAPAN: Shikoku: Tosa, Nanokowa, *K. Watanabe*, June 14, 1889 (G. TOPOTYPE); same locality, no collector, on June 21, 1891 (US, TOPOTYPE); Todigatayama, *K. Watanabe*, Aug. 11, 1888 (G). Hondo: Kobe, *K. Uno 18965* (A), *18966* (BH); Mino, *K. Shiota 6780* (A).

CULTIVATED: Europe: Kew, *G. Nicholson 2595* (under the name *P. yokohama* Sieb.); Bot. Garten Forstakadamie, Hannover, *H. Zabel* (A). United States: Arnold Arboretum *9045*, *C. E. Kobuski & C. K. Allen*, June 10, 1933 (A); Cambridge Bot. Gard., *R. Cameron*, June 18, 1918 (A).

This species is very closely related to *P. satsumi* Sieb. ex Lindl. and Paxt. Both of them have almost glabrous lower leaf surfaces, but *P. shikokianus* can readily be distinguished by its pubescent style.

Specimens collected at Kew by G. Nicholson in 1881 under the name *P. yokohama* Sieb. and by H. Zabel at Hannover, named *P. yokohamae* definitely belong here. They represent the *nomen nudum* Nicholson published in 1894.

(*To be continued*)

# STUDIES ON THE PROGENY OF TRIPLOID PHILADELPHUS AND FORSYTHIA

DEXTER R. SAMPSON *

*With one plate*

THE ARNOLD ARBORETUM breeding program for horticultural plants, under the direction of Professor Karl Sax, has included the production of artificial tetraploids. By backcrossing the tetraploids to diploids outstanding *Forsythia* triploids have been produced. The next step has been to obtain aneuploid progeny from the triploids. The present report is concerned with aneuploid progenies of triploid *Philadelphus* and *Forsythia*.

## PHILADELPHUS

**Origin of the Triploid.** Natural polyploidy within the genus *Philadelphus* has not yet been reported, all counts on pure species indicating $2n = 26$ (Bangham, 1929; Janaki Ammal, 1951). However in the progeny of the tri-species hybrid *P. purpureo-maculatus* triploids have occurred with $2n = 39$ (Janaki Ammal, 1951). These triploids, which are known as "*Bicolore*," "*Belle Etoile*" and "*Sybille*," are the finest *Philadelphus* cultivars yet to be produced. According to Janaki Ammal the parent diploid *P. purpureo-maculatus* is a hybrid between *P. lemoinei* and *P. coulteri* of Mexico, while *P. lemoinei* in turn is a hybrid between *P. coronarius* of Europe and *P. microphyllus* of southwestern U.S.A. Dr. Hu (1954) doubts that the rare *P. coulteri* was in fact one parent of *P. purpureo-maculatus*. At any rate, the genetic background of *P.* "*Bicolore*," the triploid used in the present study, is complex.

**Meiosis in the Triploid.** Meiosis was studied in *P.* "*Bicolore*" to learn what chromosome numbers could be expected in the resulting gametes.

Analysis of twelve metaphase I plates showed 2 to 7 univalents with an average of 4.42, 2 to 11 bivalents with an average of 6.42, and 4 to 11 trivalents with an average of 6.92, while two cells showed one quadrivalent each, an average of 0.17. In one cell all but two chromosomes entered into pairing relationships, with two univalents, two bivalents and eleven trivalents being formed. This behavior is interpreted to mean there is a high degree of homology among the three chromosome sets of *P.* "*Bicolore*."

Anaphase I was characterized by the occurrence of lagging univalents while a few cells showed one or two bridges.

* The writer wishes to acknowledge his indebtedness to Professor Karl Sax who initiated the project, to Mr. Louis Lipp who cared for the plants, and to Dr. S. Y. Hu who provided valuable imformation on *Philadelphus*.

Similarly Anaphase II was characterized by lagging chromosomes and an occasional bridge. The manner in which the chromosomes were being distributed to the poles was determined by counting the number of chromosomes approaching one pole in each of sixty cells. Rarely could counts be made on more than one pole per cell. The results are given in TABLE I.

TABLE I. Distribution of Chromosomes at Anaphase II of *P. "Bicolore."*

| Chromosome Number | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Observed Frequency | 1 | 3 | 2 | 5 | 5 | 13 | 14 | 8 | 3 | 3 | 3 | 0 | 0 | 0 |
| Expected Frequency | | | 3 | | 5 | 9 | 13 | 13 | 9 | 5 | | 3 | | |

The mean chromosome number for the sixty counts was 18.46 ± 2.23, which indicates a loss of 16% of the supernumerary chromosomes of the triploid. The frequencies expected if the thirteen extra chromosomes were distributed at random are given by the terms of the binomial $(0.5 + 0.5)^{13}$ taken to the nearest whole number. When the expected and observed frequencies are compared by chi-squared analysis, (classes 13–17 and 21–26 combined) the lack of fit is highly significant. $X^2 = 15.7$ and $P = < 0.01$ for four degrees of freedom.

At telophase II micronuclei were observed in a number of cells. These would account for all or part of the 16% loss of extra chromosomes.

**The triploid Progeny.** The triploid *P. "Bicolore"* sets few viable seed so that attempts to raise progeny from controlled pollinations were unsuccessful. However, by harvesting all the capsules which developed by open pollination, enough seed was obtained to start two sizable progenies.

The first progeny consisting of about 90 plants was started in the greenhouse early in 1951 but only 76 of these lived long enough to be set out in the field. By the summer of 1953 only 44 plants remained alive and their chromosome numbers were determined using iron-acetocarmine leaf squashes. The frequency of the different chromosome numbers is indicated in TABLE II and FIG. I.

The second progeny of *P. "Bicolore"* was started in the greenhouse in the spring of 1954 and all 44 of these plants survived the summer. Similarly their chromosome numbers were determined and the results are given in TABLE II and FIG. I.

TABLE II. Frequencies of different chromosome numbers in the two progenies of *P. "Bicolore."*

| Chromosome Number | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1951 Progeny | 15 | 13 | 6 | 4 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1954 Progeny | 7 | 9 | 10 | 3 | 3 | 5 | 1 | 1 | 1 | 1 | 2 | 1 |
| | 22 | 22 | 16 | 7 | 4 | 8 | 2 | 1 | 2 | 1 | 2 | 1 |

It is evident that most individuals in both progenies have the diploid

or near diploid somatic chromosome number. This is vastly different from the distribution of chromosome numbers expected in zygotes formed by the random recombination of gametes having the chromosome numbers observed at anaphase II in *P. "Bicolore."* It is also greatly different from what would be expected if *P. "Bicolore"* were pollinated by a diploid (FIG. 1). It appears that the higher aneuploid numbers are strongly se-

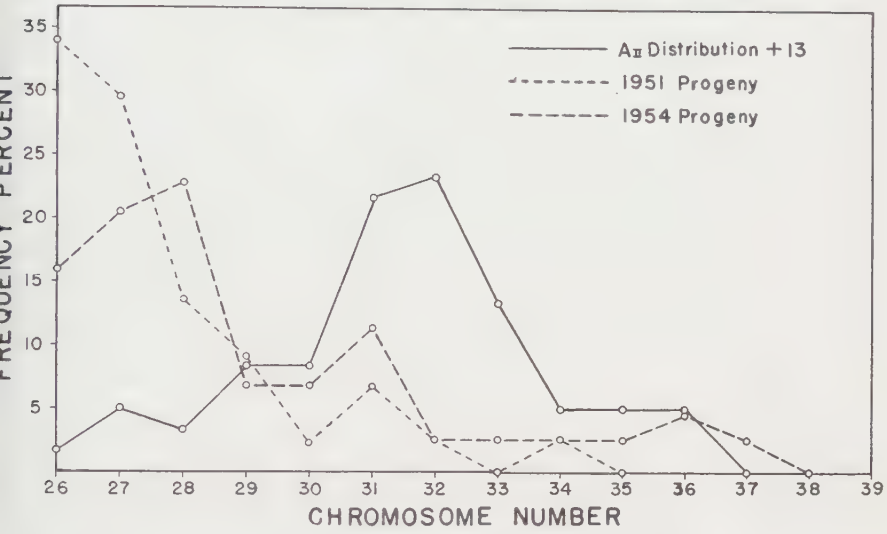



FIG. 1. Distribution of somatic chromosome numbers in the 1951 and 1954 *Philadelphus* progenies compared with the expected distribution if the triploid were pollinated by a diploid.

lected against at various stages leading to the development of seed for, although 46 per cent of the pollen of *P. "Bicolore"* appears morphologically good, only three to twenty percent of the ovules per capsule develop into full seeds. In addition, the difference between the 1951 and 1954 progenies in the chromosome number frequencies suggests that this selection against the higher aneuploids has continued well into the seedling stage. After the 1951 progeny had suffered over 50 per cent mortality its mean chromosome number was $27.6 \pm 4.6$ while the mean for the 1954 progeny, which had suffered less than one per cent mortality was $29.1 \pm 5.3$. When the two distributions are compared by chi-squared analysis (classes 29–37 combined) the difference is found to be highly significant. $X^2 = 16$ and $P = < 0.01$ for three degrees of freedom.

Both progenies were distinguished by their enormous variability in habit, leaf shape, vigor and flower morphology. Representative leaf types are shown in Plate I together with the somatic chromosome number of the plant from which the leaf was taken. Only one leaf per plant is shown and as a rule it was taken from the middle of the largest branch. It is evident there is no correlation between leaf type and chromosome number.

To obtain a size index, and thus a vigor index, for each plant the lengths of all main stems and branches were measured and the measurements added together. In 1953 the size index for the plants of the 1951 progeny ranged from 28 to 1100 inches. The three smallest plants totaled 28, 29 and 44 inches and had 27, 28 and 26 chromosomes respectively. These three dwarfs are mentioned especially as they were the only members of the 1951 progeny which failed to survive the winter of 1953–54. At the end of the 1954 growing season the 41 survivors of the 1951 progeny ranged in size index from 120 to 3400 inches. The distribution of these plants according to size index and chromosome number is given in TABLE III. To determine whether or not there was any correlation between vigor and chromosome number the coefficient of correlation between size index and chromosome number was calculated for both years using ungrouped data. For the 1953 measurements $r = -.1288$ and for the 1954 measurements $r = -.1127$. In both cases r was not statistically significant.

TABLE III. Distribution of the 1954 survivors of the 1951 *Philadelphus* triploid progeny according to size index and chromosome number. (f) indicates one or more members of a particular class flowered in 1954.

| | Chromosome Numbers | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Size Classes | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 34 | Totals |
| 100–200 ins. | | 1 | | 1f | | | 1 | | 3 |
| 201–300 | 2 | 2 | 1 | | | | | | 5 |
| 301–400 | 1 | | | 1 | | 1 | | | 3 |
| 401–500 | 1f | 4f | 1f | 2f | | 1 | | | 9 |
| 501–600 | | 3 | | | | | | | 3 |
| 601–700 | 2f | | | | 1f | | | | 3 |
| 701–800 | 2f | 1f | 1f | | | | | | 4 |
| 801–900 | 2f | | 1f | | | | | 1f | 4 |
| 901–1700 | 2f | 1 | | | | | | | 3 |
| 1701–3400 | 2f | | 1f | | | 1 | | | 4 |
| Totals | 14 | 12 | 5 | 4 | 1 | 3 | 1 | 1 | 41 |

The size index for the 1954 progeny at the end of its first growing season ranged from 2 to 190 inches. The distribution of these plants according to size index and chromosome number is given in TABLE IV. The coefficient of correlation between size index and chromosome number was calculated using ungrouped data and it was found that $r = -.3392$. Using the t method r was found to differ significantly from zero with $P = < .05$. The data were further analyzed by testing the linearity of the regression of size index on chromosome number using the analysis of variance method. A variance ratio = 1.107 was obtained which, when compared with $F_{95}(40,10) = 2.08$, is declared not significant indicating the regression does not depart from linearity. The regression was further analyzed by testing the independence of size index on chromosome number and at the 5 per cent level of significance the size index was found to be dependent on chromosome number.

TABLE IV. Distribution of the 1954 *Philadelphus* triploid progeny according to to size index and chromosome number.

| | Chromosome Numbers | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size Classes | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | Totals |
| 1–10 ins. | | 2 | | | | | 1 | | | | | 1 | 4 |
| 11–20 | | 1 | 1 | 2 | 1 | 2 | | 1 | | | | | 8 |
| 21–30 | | 1 | 3 | | | | | | | | | | 4 |
| 31–40 | | 1 | 2 | 1 | | 1 | | | 1 | | 1 | | 7 |
| 41–50 | 2 | | 2 | | 1 | 1 | | | | 1 | 1 | | 8 |
| 51–60 | | 2 | | | | | | | | | | | 2 |
| 61–70 | 1 | | | | | 1 | | | | | | | 2 |
| 71–80 | | | 2 | | | | | | | | | | 2 |
| 121–170 | 3 | 2 | | | | | | | | | | | 5 |
| 171–220 | 1 | | | | 1 | | | | | | | | 2 |
| Totals | 7 | 9 | 10 | 3 | 3 | 5 | 1 | 1 | 1 | 1 | 2 | 1 | 44 |

The vigor relationships of the two progenies are interpreted in the following manner. Some of the chromosomes of *Philadelphus* when present in an extra dose adversely affect the vigor of the individual. The more extra chromosomes an individual has, the greater is the chance of it having an adverse combination as far as vigor is concerned and thus we find a negative correlation between size index and chromosome number in the seedlings of the 1954 progeny. Presumably the more extreme combinations are eliminated in the gametic and embryonic stages thus explaining the great departure from expected of the distribution of chromosome numbers in both progenies. Nevertheless, a few vigorous aneuploids do occur, indicating some combinations of extra chromosomes do not adversely affect the vigor of the plant. Turning to the 1951 progeny we see that dwarfs and weaklings have less ability to survive than their more vigorous siblings as the three smallest members of the 1951 progeny in 1953 were the only ones which failed to survive the winter of 1953–54. Now the 1951 progeny had suffered over 50 per cent mortality before the chromosome numbers of the survivors were determined in 1953. If it is assumed that most of these deaths were plants lacking in vigor, then it follows that mortality was greater among the higher aneuploids than among the lower. This would cause a shift of the mean chromosome number of the 1951 progeny toward the diploid level, which is exactly what is indicated when the distribution of chromosome numbers found in the survivors of the 1951 progeny in 1953 is compared with that found in the 1954 seedlings. In addition, the removal of the less vigorous higher aneuploids of the 1951 progeny would decrease the correlation between size index and chromosome number thus explaining the lack of such correlation in the survivors of the 1951 progeny as indicated by statistical analysis.

In 1953 eight members of the 1951 progeny flowered, while in 1954 eighteen plants did so. The distribution of flowering plants according to size index and chromosome number is shown in TABLE III. Most of the flowers were quite ordinary, many were small and a few were teratological.

However, two plants had flowers as large as *P.* "*Bicolore*," one with a flat pure white corolla, and the other with a cup shaped corolla having a pink spot at the base of each petal. This was the only plant to have the pink petal base characteristic of *P.* "*Bicolore*." Both these plants promise to be more hardy and vigorous than *P.* "*Bicolore*" in the New England area.

## FORSYTHIA

The triploid parent of the *Forsythia* aneuploids is an artificial autotriploid ($3n = 42$) of *F. intermedia*. The origin of the triploid is described by Hyde (1951). Like *P.* "*Bicolore*" the triploid *Forsythia* sets very few seed and only small progenies have been obtained, numbering twenty-six plants in all. One of these plants was started in 1950 from seed obtained by open pollination, but since the triploid *Forsythia* is short-styled and self-incompatible the pollen parents of progenies by open pollination could have been only diploid long-styled species. Seven plants were started in 1951 from seed obtained by pollinating the triploid by diploid *F. intermedia*. The remainder are from seed obtained by open pollination; one was started in 1951, three in 1952 and fourteen in 1953. It is not known whether or not the 1950, '51 and '52 progenies were originally larger. Of the 1953 progeny, however, all the plants which were set out in the field in 1953 were still alive at the end of the 1954 season.

The chromosome numbers of the twenty-six plants were determined using iron aceto-carmine leaf squashes. The results are given in TABLE V.

TABLE V. Distribution of the somatic chromosome numbers in progenies from triploid *Forsythia intermedia*.

| Chromosome Number | 31 | 36 | 39 | 43 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 56 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 progeny O.P. | | | | | | | | | 1 | | | | | |
| 1951 " $3n \times 2n$ | | 1 | | 1 | | | 1 | | | 1 | | 2 | 1 | |
| 1951 " O.P. | | | | | | | | | | | | | | 1 |
| 1952 " O.P. | | | 1 | 1 | | | | 1 | | | | | | |
| 1953 " O.P. | 1 | 1 | | | 2 | 1 | | 2 | 2 | 1 | 2 | 1 | | 1 |
| Total | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 1 | 2 |

In the *Forsythia* progenies the chromosome numbers are scattered between the $2n$ and $4n$ levels with most individuals lying between the $3n$ and $4n$ levels. This distribution is very different from that of the *Philadelphus* triploid progenies where most individuals had diploid or near diploid chromosome numbers.

The *Forsythia* aneuploids are very variable in morphological characters and several striking and bizarre new forms occurred among them. Representative leaf types taken from the middle part of the largest branch of a plant are illustrated in PLATE I, together with the chromosome number of the plant. If their origin were unknown one might hesitate to include some of these aneuploids in the genus *Forsythia*. Unfortunately most of the plants have not yet flowered.

As with the *Philadelphus* progenies, the lengths of all main stems and branches of the *Forsythia* plants were measured after the 1954 growing season. The measurements from each plant were added together to give a size index for that particular plant. When the size index was plotted against chromosome number, for each progeny, there appeared to be no correlation between size and chromosome number, larger and smaller plants being scattered all along the line. However, two outstanding differences, with regard to vigor, were evident between the *Philadelphus* and *Forsythia* triploid progenies. Firstly, there were no extreme dwarfs among the *Forsythia* plants, and secondly, the range in size index was much greater for the *Philadelphus* plants. In the 1953 *Forsythia* progeny the size index of the largest plant was 5.4 times greater than that for the smallest plant, while in the 1951, $3n \times 2n$ *Forsythia* progeny the size index for the largest plant was 5.3 times greater than that for the smallest. In the 1951 *Philadelphus* progeny measured in 1954 the index for the largest plant was 28 times greater than that for the smallest, while in the 1953 progeny the largest was 95 times greater than the smallest. It is possible that the difference in vigor between the triploid progenies of these two genera is due to the same factors responsible for the difference in distribution of chromosome numbers in their triploid progenies.

## DISCUSSION

The chromosome numbers observed in the progenies from triploid *Philadelphus* and *Forsythia* fell into two strongly contrasting distributional patterns with most *Philadelphus* plants having the diploid or near diploid chromosome number while most of the *Forsythia* plants had chromosome numbers between the triploid and tetraploid levels. In an attempt to evaluate the factors producing this discrepancy a survey was made of the literature on triploid progenies and factors affecting their chromosome numbers.

**Meiosis in Triploids.** The distribution of aneuploid chromosome numbers in the progeny of triploids depends, in the first place, on the distribution of the extra chromosomes of the triploid parent during meiosis. In general it has been found that the extra chromosomes are distributed to the poles at random regardless of whether they pair in trivalents or remain as univalents. This statement is supported by the work of Belling (1921) on *Canna*, Belling and Blakeslee (1922) on *Datura*, Kihara (1924) on wheat, Lesley (1926) on tomato, Dermen (1930) on *Petunia*, Skovsted (1933) on cotton, Sax (1937) on *Tradescantia*, Satina and Blakeslee (1937) on *Datura*, Goodspeed and Avery (1939) on *Nicotiana* and Skalinska (1945) on *Aquilegia*. The failure of a few lagging univalents to be included in the telophase nuclei and the subsequent formation of micronuclei has been frequently observed. This leads to a slight departure from random distribution as observed in our *Philadelphus* material.

Chromosome counts on the microspores of triploids have been of value in indicating the percentage of extra chromosomes lost during meiosis.

Upcott and Philp (1939) present a table summarizing new and previously published information on this aspect of the problem. Their work on three tulip species and one *Tradescantia* species indicates practically no loss of extra chromosomes while the findings of Darlington (1929) and King (1933) on two other species of *Tradescantia* are similar. On the other hand, elimination of 19% of the extra chromosomes was found by Upcott and Philp in one tulip species while other workers have observed roughly 11% loss in *Datura* (Satina and Blakeslee, 1937), 10% in hyacinth (Darlington, 1926) and 10 to 12.5% in three species of *Allium* (Levan, 1936). To this enumeration may be added the findings of Punyasingh (1947) on the microspores of triploid maize where only 1.5% loss was observed, while, on the other hand, elimination of 9.5% of the extra chromosomes was found by Belling (1924) in hyacinth, 11.5% in *Narcissus* (Nagao, 1935), 7% in *Tradescantia* (Sax, 1937), 32% in *Coffea* (Krug and Mendes, 1940), 10.3% in hyacinth (Darlington and Mather, 1944) and 29.7% in rye (Lamm, 1944). It must be remembered, however, that the above calculations indicate deviations which could in part or entirely be due to the failure of microspores with certain chromosome combinations to divide, rather than to any loss of chromosomes at meiosis. Thus, when the method for calculating percentage loss (Upcott and Philp, 1939) is applied to the findings of Giles (1941) on *Tradescantia*, an apparent gain of 9.3% is indicated. Giles suggests deficiencies leading to abortive microspores would be more common in cells having fewer extra chromosomes. Similarly Darlington and Mather (1944) found certain chromosome combinations had been selected against in the microspores of triploid hyacinth.

**Triploid Progenies.** Since 1908, when Gates reported his discovery of triploidy, a considerable body of literature on the chromosome numbers found in the progeny of triploids has been built up. In 1933 East commented, "When the records of the studies of the progenies of triploids are listed, they prove to be a variable lot," and the work of the past twenty years has not decreased the variability. In an attempt to summarize these findings each case has been assigned to one of seven categories depending on the distributional pattern of the chromosome numbers. In most instances it was obvious to which category one particular case belonged but a few decisions have been highly arbitrary.

GROUP I. To this category have been assigned those progenies whose chromosome numbers are as would be expected if the extra chromosomes of the triploid parent were distributed to the gametes at random and if gametes having different numbers functioned and gave viable progeny equally well. Seldom has a perfectly normal distribution been observed, but the findings of van Overeem (1921) on the progeny from $3n \times 4n$ *Oenothera* approach it. Cases were assigned to this category if they had the expected aneuploid numbers well represented and at the same time showed no great overrepresentation of the euploid members. These include the findings of: van Overeem (1921) on $3n \times 2n$ and $3n$ selfed

*Oenothera* progenies; De Vries and Boedijn (1924) on $3n \times 2n$ *Oenothera* progeny; Dulfer (1926) on $3n \times 2n$ *Oenothera* progeny; Gairdner (1926) on $3n$ selfed *Campanula* progeny; McClintock (1929) on the progeny of $3n \times 2n$ maize; Darlington and Moffett (1930) on the progeny of $3n$ open pollinated apples; Moffett (1931) on the progenies of $3n \times 2n$ and $3n$ selfed apples; Capinpin (1933) on $3n \times 2n$ *Oenothera* progeny; East (1933) on $3n \times 2n$ *Nicotiana* progeny; Nebel (1933) on the progenies from $2n \times 3n$, $3n \times 3n$ and $3n \times 2n$ apple crosses; Longley (1934) on the progeny of *Euchlaena-Zea* ($3n$) $\times$ *Zea* ($2n$); Dermen (1936) on the progeny of open pollinated Baldwin apples; Ramanujam (1939) on open pollinated $3n$ rice progeny; Bergström (1938) on the progeny from $3n$ apples; Wanscher (1939) on the progeny from $3n$ apples; Upcott and Philp (1939) on $3n \times 2n$ tulip progeny; Johnsson (1942) on $3n \times 3n$ *Populus* progeny; Johnsson (1946) on $3n \times 3n$ *Betula* progeny, and Punyasingh (1947) on the progenies from $3n \times 2n$ and $3n \times 3n$ maize crosses.

Group II. The progenies assigned to this group show more or less random distribution of aneuploid numbers as in Group I but, in addition, the formation of unreduced gametes in the triploid results in the appearance of tetraploids when a diploid is the other parent, or in pentaploids when a tetraploid is the other parent. To this class belong the findings of: Lammerts (1929) on $3n \times 2n$ and $3n \times 4n$ *Nicotiana* progenies; Goodspeed and Avery (1939) on $3n \times 2n$ *Nicotiana* progeny; Bergström (1940) on progeny from $2n \times 3n$ *Populus* and Johnsson (1942) on progeny from $3n \times 2n$ *Populus*.

Group III. This category includes progenies whose chromosome numbers are mostly at or near the diploid level when the female parent is diploid or near the tetraploid level when the female parent is tetraploid. These include the progenies studied by: van Overeem (1921) from *Oenothera biennis* ($2n$) $\times$ *Oe. lamarkiana* ($3n$); Lesley (1928) from $2n \times 3n$ tomato; Dermen (1930) from $2n \times 3n$ *Petunia*; Gairdner and Darlington (1931) from $2n \times 3n$ *Campanula;* Lammerts (1931) from $4n \times 3n$ *Nicotiana*; Yarnell (1931) from $2n \times 3n$ *Fragaria*; Satina et al. (1938) from $2n \times 3n$ *Datura* and Punyasingh (1947) from $2n \times 3n$ maize.

Group IV. As in Group III, the progenies included in this category have mostly diploid or near diploid chromosome numbers but with the difference that in these cases the female parent was triploid. These include studies reported by: Belling and Blakeslee (1922) on *Datura*; Boedijn (1925) on *Oenothera*; Karpechenko (1928) on progenies from $3n$ *Raphanobrassica* selfed and $\times$ *Raphanus*; Lesley (1928) on tomato; Yarnell (1931) on *Fragaria*; Satina et al. (1938) on *Datura*; Mangelsdorf and Reeves (1939) on $3n$ *Zea-Tripsacum* $\times$ *Zea*; Levan (1942) on sugar beets; Lamm (1944) on rye; Myers (1944) on *Lolium*; Skalinska (1945) on *Aquilegia*; Kerber (1954) on barley and the present study on *Philadelphus*.

GROUP V. Progenies included in this group have mostly tetraploid chromosome numbers and are derived from triploid female parents. They include the findings of: Dermen (1930) on selfed 3*n* *Petunia* progeny; Huskins (1934) on progeny of selfed 3*n* tomato; Janaki-Ammal (1934) on selfed 3*n* egg-plant progeny; Matsuda (1935) on progenies from 3*n* × 4*n* and 3*n* × 3*n* *Petunia*; Krug and Mendes (1940) on progeny from open pollinated 3*n* *Coffea* and Skalinska (1945) on 3*n* × 4*n* *Aquilegia* progeny.

GROUP VI. Triploid progenies having two or more euploid levels greatly overrepresented were assigned to this category. Van Overeem (1921) in progeny from 4*n* × 3*n* *Oenothera lamarkiana* found mostly near 3*n* and 4*n* individuals while *Oenothera lata* (2*n*) × *Oe. lamarkiana* (3*n*) gave plants with chromosome numbers clustered about the 2*n*, 3*n* and 4*n* levels. McClintock (1929) from 2*n* × 3*n* maize obtained mostly 2*n* and near 2*n* plants plus one 3*n*. Navashin (1929) obtained mostly 2*n* and 3*n* progeny from triploid *Crepis*. Dermen (1930) from 3*n* × 4*n* *Petunia* obtained near 4*n* and 5*n* progenies. Hollingshead (1930) from selfed 3*n* *Crepis* obtained an extensive aneuploid series but the 2*n* and 3*n* levels were overrepresented. Thompson (1931) from selfed 3*n* wheat hybrids obtained mostly 4*n* and near 4*n* plants but the 5*n* and 6*n* levels were also represented. Nishiyama (1934) in the progeny of 3*n* *Avena* hybrids found the near 2*n* and near 4*n* levels greatly overrepresented. Larter (1937) in 3*n* × 2*n* banana progeny found the tetraploid and heptaploid levels overrepresented. Upcott and Philp (1939) in 2*n* × 3*n* *Tulipa* progeny obtained only 2*n* and near 2*n*, near 3*n* and 4*n* plants. Nordenskiöld (1941) in the progeny of 3*n* × 6*n* *Phleum* obtained plants at and near the 5*n* and 6*n* levels. Cheesman and Dodds (1942) from many 3*n* × 2*n* banana crosses obtained 2*n*, 3*n*, especially 4*n*, a few 5*n*, 7*n* and 8*n* plants but aneuploids were rare. Levan (1942) from 2*n* × 3*n* sugar beets obtained mostly 2*n* and near 2*n* plants with a few at and near 3*n*, while from 3*n* × 3*n* sugar beets all the numbers between 2*n* and 4*n* were found but the 2*n* and 3*n* levels were greatly overrepresented. Einset (1945) from 3*n* open pollinated apples obtained mostly aneuploid progeny between 2*n* and 3*n* but the *n*, 2*n*, 3*n* and especially 4*n* levels were overrepresented. Skalinska (1945) from selfed and open pollinated *Aquilegia* obtained only 2*n*, near 2*n* and 4*n* individuals.

GROUP VII. Miscellaneous cases which fit none of the above six patterns have been lumped into this unnatural group. Goodspeed et al. (1926) in the progeny from 3*n* × 2*n* *Nicotiana* found a good representation of the aneuploid numbers between the 2*n* and 3*n* levels plus a high percentage of triploids. Lammerts (1931) from 3*n* × 3*n* *Nicotiana* obtained mostly 6*n* plants. Longley (1934) from a *Zea* (2*n*) × *Euchlaena-Zea* (3*n*) cross obtained entirely 3*n* or near 3*n* plants while 3*n* × 3*n* gave mostly aneuploids between the 3*n* and 4*n* levels. Matsuda (1935) in a 3*n* × 2*n* *Petunia* progeny obtained only 3*n* or near 3*n* plants. Levan (1936) from open pollinated 3*n* *Allium* obtained most of the aneuploids between

*2n* and *4n* plus a few higher, but most plants were between the *3n* and *4n* levels. Satô (1937) from *3n* × *3n Lilium* obtained all the aneuploids from *2n* to *3n* plus a few higher but lower aneuploids and triploids were most frequent. The findings of the present study on progeny from *3n Forsythia* are similar to those of Levan (above) in that most individuals were aneuploids between the *3n* and *4n* levels.

An examination of the foregoing data indicates that in some genera, notably *Malus* and *Populus* which are secondary polyploids, the chromosome numbers found in triploid progenies approximate a normal distribution, regardless of whether or not the triploid is the female parent. In other genera, as *Oenothera* and *Zea*, random distribution of the extra chromosomes to the progeny results only when the triploid is the female parent indicating aneuploidy is more strongly selected against in the male than in the female gametophyte. In the cases listed in Group IV, however, aneuploidy is selected against even when the female is triploid. It is also evident that, in the majority of triploid progenies, euploidy is highly favored sometimes to the almost complete exclusion of the aneuploids, or, as in *Crepis* and sugar beets, the euploids are accompanied by a high percentage of aneuploids.

Attempted explanations of these phenomena have favored the theory of gene balance elaborated by Bridges (1922). It is assumed that the genetic complement of a normal diploid is such as to permit the individual to develop and function as an integrated organism. Additions of whole genomes to the basic complement affect but little this gene balance, and hence the lower euploid levels in triploid progenies are not markedly selected against. The effect of the addition of extra chromosomes depends upon the genic content of these chromosomes and how the extra genes affect the gene balance of the individual. Thus the long chromosomes of hyacinth, for example, behave as if they each possessed an internal gene balance (Darlington and Mather, 1944) so that presumably any number and combination may be added to a diploid without greatly disturbing the gene balance of the organism. An extensive series of aneuploid hyacinths is known in cultivation. Similarly the recent work of Avers (1954) indicates the chromosomes of *Aster* possess a high degree of internal balance. However, in most cases gene balance is not realized within individual chromosomes so that, as first suggested by Winkler (1916), aneuploids are likely to differ more from diploids than are polyploids.

The triploid progenies which deviate greatly from expected in the distribution of their chromosome numbers probably do so because the extremely unbalanced combinations have been eliminated in the gametic and embryonic stages. The degree of gene unbalance in the remaining viable aneuploids is presumably reflected in the vigor of the plants. Thus the occurrence of a high proportion of vigorous aneuploids in the *Forsythia* progenies suggests many of the chromosomes of this genus possess a high degree of internal gene balance making possible many vigorous high aneuploid combinations. The reverse would be true for *Philadelphus* and other genera where aneuploidy is associated with lack of vigor. Such an

association has been most beautifully demonstrated in sugar beets (Levan, 1942) where curves for the mean weight of tops and roots for each chromosome number reach maxima at the $2n$, $3n$ and $4n$ levels with minima midway between each peak. Similar observations on the vigor of triploid progeny have been made by Levan (1936) on *Allium*, and by Bergström (1940) on *Populus*.

The frequent lack of vigor in aneuploid plants is a drawback to the use of aneuploidy in plant breeding. However, aneuploids are often as variable in vigor as in morphological characters so that Johnsson (1942) found an occasional vigorous aneuploid *Populus* and Nebel (1933) reported a few vigorous aneuploid apples although most such apples are very poor in vigor as emphasized by Crane and Lawrence (1930, 1934) and Einset (1948). Similarly vigorous aneuploids occurred among our *Philadelphus* and *Forsythia* plants giving ample indication of the value of aneuploidy in the production of new and exciting horticultural plants.

## SUMMARY

Chromosome numbers were determined for two progenies from a triploid *Philadelphus*. In both progenies the distribution of the numbers was found to be strongly skewed toward the diploid level. Statistical analysis indicated a negative correlation between vigor and chromosome number in the one-year-old progeny, but this correlation had been lost in the four-year-old progeny, presumably due to the death of unbalanced weaklings.

Similarly chromosome numbers were determined for five small progenies from a triploid *Forsythia*. Contrasting to the situation in *Philadelphus* the chromosome numbers in the *Forsythia* progenies were scattered between the diploid and tetraploid levels with most individuals between the triploid and tetraploid levels. No correlation between vigor and chromosome number was evident in the *Forsythia* aneuploids.

The results are interpreted as indicating that the chromosomes of *Philadelphus* possess a low degree of internal gene balance for viability factors, contrasting with the situation in *Forsythia* where a high degree of internal gene balance for viability factors is postulated.

## LITERATURE CITED

AVERS, C. J., 1954. Chromosome behavior in fertile triploid *Aster* hybrids. Genetics **39**:117–126.

BANGHAM, W., 1929. The chromosomes of some species of the genus *Philadelphus*. Jour. Arnold Arb. **10**:167–169.

BELLING, J., 1921. The behavior of homologous chromosomes in a triploid *Canna*. Proc. Nat. Acad. Sci. **7**:197–201.

———, 1924. The distribution of chromosomes in the pollen grains of a triploid hyacinth. Amer. Nat. **58**:440–446.

——— AND A. F. BLAKESLEE, 1922. The assortment of chromosomes in triploid Daturas. Amer. Nat. **56**:339–346.

BERGSTRÖM, I., 1938. Tetraploid apple seedlings obtained from the progeny of triploid varieties. Hereditas **24**:210–215.

BERGSTRÖM, I., 1940. On the progeny of diploid × triploid *Populus tremula*. Hereditas **26**:191–201.

BOEDIJN, K., 1925. Der Zusammenhang zwischen den Chromosomen und Mutationen bei *Oenothera Lamarkiana*. Rec. Trav. Bot. Néer. **22**:173–220.

BRIDGES, C. B., 1922. The origin and variations in sexual and sex-limited characters. Amer. Nat. **56**:51–63.

CAPINPIN, J. M., 1933. Studies on the genetics and cytology of triploid Oenotheras. Cytologia **4**:355–426.

CHEESMAN, E. E., AND K. S. DODDS, 1942. Genetical and cytological studies of *Musa*. IV. Certain triploid clones. Jour. Genetics **43**:337–357:1942.

CRANE, M. B. AND W. J. C. LAWRENCE, 1930. Fertility and vigor of apples in relation to chromosome number. Jour. Genetics **22**:153–163.

——— AND ———, 1934. The genetics of garden plants. 139–144. Macmillan and Co., London.

DARLINGTON, C. D., 1926. Chromosome studies in the *Scilleae*. Jour. Genetics **16**:237–251.

———, 1929. Chromosome behaviour and structural hybridity in the *Tradescantiae*. Jour. Genetics **21**:207–286.

——— AND K. MATHER, 1944. Chromosome balance and interaction in *Hyacinthus*. Jour. Genetics **46**:52–61.

——— AND A. A. MOFFETT, 1930. Primary and secondary chromosome balance in *Pyrus*. Jour. Genetics **22**:129–151.

DERMEN, H., 1930. Polyploidy in *Petunia*. Amer. Jour. Bot. **18**:250–261.

———, 1936. Fertilization in the Baldwin apple, a triploid variety. Jour. Arnold Arb. **17**:106–108.

DULFER, H., 1926. Die Erblichkeitserscheinungen der *Oenothera Lamarckiana semigigas*. Rec. Trav. Bot. Néer. **23**:1–72.

EAST, E. M., 1933. The behavior of a triploid in *Nicotiana Tabacum* L. Amer. Jour. Bot. **20**:269–289.

EINSET, J., 1945. The spontaneous origin of polyploid apples. Proc. Amer. Soc. Hort. Sci. **46**:91–93.

———, 1948. The occurrence of spontaneous triploids and tetraploids in apples. Proc. Amer. Soc. Hort. Sci. **51**:61–63.

GAIRDNER, A. E., 1926. *Campanula persicifolia* and its tetraploid form "Telham Beauty." Jour. Genetics **16**:341–351.

——— AND C. D. DARLINGTON, 1931. Ring formation in diploid and polyploid *Campanula persicifolia*. Genetics **13**:113–150.

GATES, R. R., 1908. The chromosomes of *Oenothera*. Science **27**:193–195.

GILES, N., 1941. Spontaneous chromosome aberrations in triploid *Tradescantia* hybrids. Genetics **26**:632–649.

GOODSPEED, T. H., R. E. CLAUSEN AND R. H. CHIPMAN, 1926. Interspecific hybridization in *Nicotiana*. IV. Some cytological features of the *paniculata-rustica* hybrid and its derivatives. Univ. Calif. Pub. Bot. **11**:103–115.

——— AND P. AVERY, 1939. Trisomic and other types in *Nicotiana sylvestris*. Jour. Genetics **38**:381–458.

HOLLINGSHEAD, L., 1930. Cytological investigations of hybrids and hybrid derivatives of *Crepis capillaris* and *Crepis tectorum*. Univ. Calif. Pub. Agric. Sci. **6**:55–94.

HU, S. Y., 1954. A monograph of the genus *Philadelphus*. Jour. Arnold Arb. **35**:275–333.

HUSKINS, C. L., 1934. Anomalous segregation of a triploid tomato. Jour. Hered. **25**:281–286.

HYDE, B., 1951. *Forsythia* polyploids. Jour. Arnold Arb. **32**:155–156.

JANAKI AMMAL, E. K., 1934. Polyploidy in *Solanum Melongena* L. Cytologia **5**:453–459.

———, 1951. Chromosomes and the evolution of garden *Philadelphus*. Jour. Roy. Hort. Soc. **76**:269–275.

JOHNSSON, H., 1942. Cytological studies of triploid progenies of *Populus tremula*. Hereditas **28**:306–312.

———, 1946. Progeny of triploid *Betula verrucosa* Erh. Bot. Not. **1946**: 285–290.

KARPECHENKO, G. D., 1928. Polyploid hybrids of *Raphanus sativus* L. × *Brassica oleracea* L. Zeitschr. f. induk. Abstamm. und Vererb. **48**:1–85.

KERBER, E. R., 1954. Trisomics in barley. Science **120**:808–809.

KIHARA, H., 1924. Cytologische und genetische Studien bei wichtigen Getreidearten. Mem. Coll. Sci. Kyoto Imp. Univ. **1**:1–200.

KING, E., 1933. Chromosome behavior in a triploid *Tradescantia*. Jour. Hered. **24**:253–256.

KRUG, C. A., AND A. J. T. MENDES, 1940. Cytological observations in *Coffea* IV. Jour. Genetics **39**:189–203.

LAMM, R., 1944. Chromosome behavior in a triploid rye plant. Hereditas **30**: 137–144.

LAMMERTS, W. E., 1929. Interspecific hybridization in *Nicotiana* IX. Genetics **14**:286–304.

———, 1931, *Ibid.* XII. Genetics **16**:191–211.

LARTER, L. N. H., 1937. Report of the Government Botanist. In Ann. Rep. Dep. Sci. Agric. Jamaica for the year ended 31 Dec. 1936:65–72. Cited by Cheesman and Dodds, 1942. Jour. Genetics **43**:337–357.

LESLEY, J. W., 1928. A cytological and genetical study of progenies of triploid tomatoes. Genetics **13**:1–43.

LESLEY, M. M., 1926. Maturation in diploid and triploid tomatoes. Genetics **11**:267–279.

LEVAN, A., 1936. Zytologische Studien an *Allium Schoenoprasum*. Hereditas **22**:1–128:1936.

———, 1942. The effect of chromosomal variation in sugar beets. Hereditas **28**:345–399.

LONGLEY, A. E., 1934. Chromosomes in hybrids between *Euchlaena perennis* and *Zea Mays*. Jour. Agric. Res. **48**:789–806.

MANGELSDORF, P. C., AND R. G. REEVES, 1939. The origin of Indian corn and its relatives. Bull. Texas Agric. Exp. Sta. **574**:1–315.

MATSUDA, H., 1935. Cytological studies of genus *Petunia*. Cytologia **6**:502–522.

MCCLINTOCK, B., 1929. A cytological and genetical study of triploid maize. Genetics **14**:180–222.

MOFFETT, A. A., 1931. The chromosome constitution of *Pomoideae*. Proc. Roy. Soc., London. B, **108**:423–446.

MYERS, W. M., 1944. Cytological studies of a triploid perennial ryegrass and its progeny. Jour. Hered. **35**:17–23.

NAGAO, S., 1935. Distribution of pollen grains in certain triploid and hypertriploid *Narcissus* plants. Jap. Jour. Genetics **11**:1–5.

NAVASHIN, M., 1929. Studies on polyploidy I. Cytological investigations on triploidy in *Crepis*. Univ. Calif. Pub. Agric. Sci. **2**:377–400.

NEBEL, B. R., 1933. Chromosome numbers in aneuploid apple seedlings. N. Y. State Agric. Exp. Sta. Bull. **209**:1–12.

NISHIYAMA, J., 1934. The genetics and cytology of certain cereals. VI. Chromosome behavior and its bearing on inheritance in triploid *Avena* hybrids. Mem. Coll. Agric., Kyoto Imp. Univ. **32**:1–157.

NORDENSKIÖLD, V., 1941. Cytological investigation in triploid *Phleum*. Bot. Not. **1941**:12–32.

OVEREEM, C. VAN, 1921. Über Formen mit abweichenden Chromosomenzahl bei *Oenothera*. Beih. Bot. Centralbl. **38**:73–113.

PUNYASINGH, K., 1947. Chromosome numbers in crosses of diploid, triploid and tetraploid maize. Genetics **32**:541–554.

RAMANUJAM, S., 1937. Cytological studies in the *Oryzeae* II. Cytological behavior of an auto-triploid in rice (*Oryza sativa* L.). Jour. Genetics **35**:183–221.

SATINA S. AND A. F. BLAKESLEE, 1937. Chromosome behavior in triploids of *Datura Stramonium*. I. The male gametophyte. Amer. Jour. Bot. **24**:518–527.

———, ——— AND A. G. AVERY, 1938. Chromosome behavior in triploid *Datura* III. The seed. Amer. Jour. Bot. **25**:595–602.

SATÔ, M., 1937. Chromosome variation in the progeny of triploid *Lilium tigrinum*. Cytologia F. J. Vol. **2**:1056–1061.

SAX, K., 1937. Chromosome behavior and nuclear development in *Tradescantia*. Genetics **22**:523–533.

SKALINSKA, M., 1945. Cytogenetic studies in triploid hybrids of *Aquilegia*. Jour. Genetics **47**:87–111.

SKOVSTED, A., 1933. Cytological studies in cotton I. The mitosis and the meiosis in diploid and triploid Asiatic cotton. Ann. Bot. **47**:227–251.

THOMPSON, W. P., 1931. Cytology and genetics of crosses between fourteen- and seven-chromosome species of wheat. Genetics **16**:309–324.

UPCOTT, M. and J. PHILP, 1939. The genetic structure of *Tulipa* IV. Balance, selection and fertility. Jour. Genetics **38**:91–123.

VRIES, H. DE AND K. BOEDIJN, 1924. Die Gruppierung der Mutaten von *Oenothera Lamarckiana*. Ber. Deutsch. Bot. Ges. **42**:174–178.

WANSCHER, J. H., 1939. Contribution to the cytology and life history of apple and pear. Den kongl. Vet.- og Landbohöjskoles Aarsskrift. København. Cited by Johnsson, 1942, Hereditas **28**:306–312.

WINKLER, H., 1916. Über die experimentelle Erzeugung von Pflanzen mit abweichenden Chromosomenzahlen. Zeitschr. f. Bot. **8**:417–531.

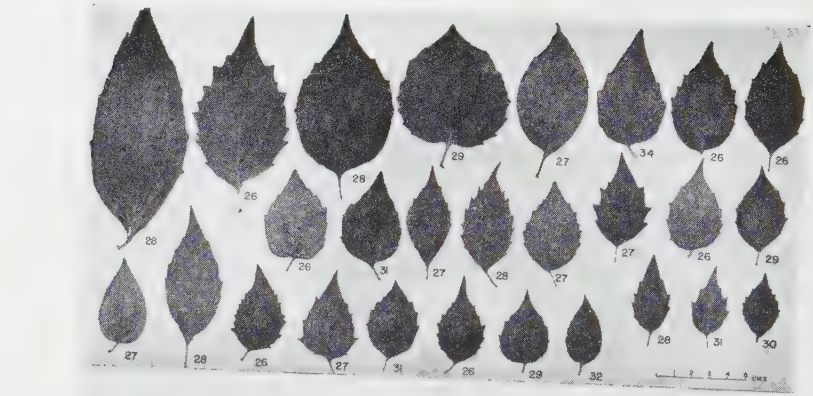
YARNELL, S. H., 1931. A study of certain polyploid and aneuploid forms of *Fragaria*. Genetics **16**:455–489.

## EXPLANATION OF PLATE I

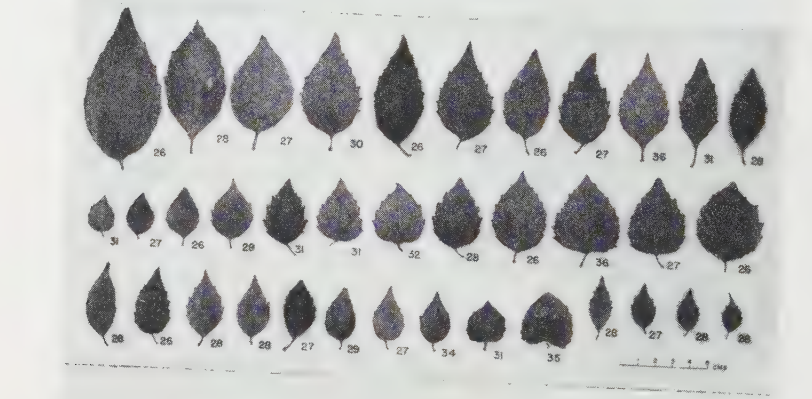
TOP. Representative leaf types of the 1951 *Philadelphus* triploid progeny. The numbers indicate the somatic chromosome number of the plant from which the leaf was taken.

CENTER. Representative leaf types of the 1954 *Philadelphus* triploid progeny. The numbers indicate the somatic chromosome number of the plant from which the leaf was taken.

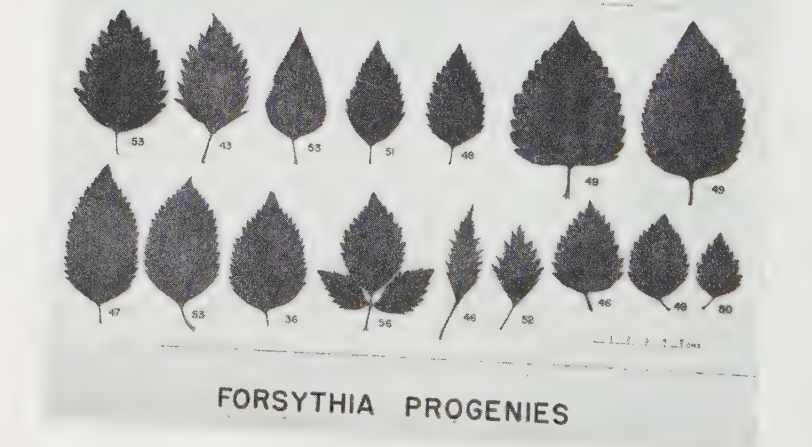
BOTTOM. Representative leaf types of the *Forsythia* triploid progenies. Top row, left to right: 1–5, 1951 $3n \times 2n$; 6, 1952 O.P.; 7 and entire bottom row, 1953 O.P. Numbers indicate somatic chromosome number of plant from which leaf was taken.



PHILADELPHUS 1951 PROGENY



PHILADELPHUS 1954 PROGENY



FORSYTHIA PROGENIES

SAMPSON, TRIPLOID PHILADELPHUS AND FORSYTHIA

# GEOGRAPHICAL DISTRIBUTION OF THE EUPOMATIACEAE

A. T. Hotchkiss

With the renewed interest, in recent years, in the anatomy, morphology and inter-relationships of members of the ranalian group of angiosperms, the genus *Eupomatia* remains outstanding as one of these plants which has not been intensively reinvestigated in the light of the newer discoveries and interpretations in this field.

In the present paper the history of the classification and the geographical distribution of *Eupomatia* are discussed.

The genus *Eupomatia* R.Br. forms the monogeneric family Eupomatiaceae. *Eupomatia* was discovered by Robert Brown in the colony of Port Jackson (Sydney, N.S.W.), Australia, while he was acting as naturalist on the voyage of M. Flinders to Australia in 1802–03. Brown's description (5, 6) of the genus and species which he named *E. laurina* appear in the Appendix and illustrations by F. Bauer in the Atlas of Flinders' account of his voyage.

In assigning the new genus to a family, Brown observed, "This genus forms a very unexpected addition to Anonaceae, of which it will constitute a distinct section. . . . the affinity . . . is chiefly determined by the structure of the seed." Brown gave as his locality, "woods and thickets in the colony of Port Jackson, especially in the mountainous districts, and on the banks of the principal rivers. . . ."

The second species, *E. bennettii* F.v.Muell., was first described by W. J. Hooker (21) in an illustrated article in Curtis's Botanical Magazine, under the name of *E. laurina* R.Br. His material, blooming plants about a foot high, were supplied by the Messrs. Henderson who had apparently forgotten the precise source of origin of the plants. A handwritten marginal note in this number of Curtis's Botanical Magazine in the library of the National Herbarium at Sydney, N.S.W. is significant —

*The plant from which this drawing was made was collected by me at Brisbane in June 1854 and sent same year to Mr. Henderson. The description of the plant is correct but that quoted from Brown refers to another plant altogether.*

*C. Moore.*

— and probably explains their origin. In describing the plant Hooker noted that, "there are some differences between our plant and the figures made by Mr. Bauer and description of Mr. Brown, but not sufficient to justify us in forming of it a distinct species."

In 1858, F. v. Mueller described and named this plant (26) citing Hooker's description and figure and pointed out that Charles Moore first introduced it into England. The type specimen in the National Herbarium

at Melbourne bears the information: *Eupomatia bennettii* Ferd.Mueller. Moreton Bay, Dr. Mueller.

Another plant first described as a species of *Eupomatia*, is *Himantandra belgraveana* (F. v. Muell.) F. v. Muell., the nomenclature of which is reviewed by A. C. Smith (28).

The genus *Eupomatia* was separated from the family Anonaceae and placed in an independent, monogeneric family, the Eupomatiaceae, by L. Diels in 1912 (8). Following Robert Brown's somewhat tentative disposition of the genus in 1814, *Eupomatia* had been placed in the Anonaceae by Meisner in 1836 (24) who referred to it as a deviationist genus; Endlicher in 1839 (10) under *Anonaceis affines*; Mueller in 1858 (26) under the *Eupomaticae*; Bentham and Hooker in 1862 (4) under the tribe *Miliuseae*; Baillon in 1871 (2) who referred to *Eupomatia* as an aberrant genus; Engler and Prantl in 1891 (14) under the *Eupomatieae*, but in 1908 (15) and 1909 (11) under the sub-family *Eupomatioideae*. On the other hand, Bartling in 1830 (3) in emphasizing the affinity of the Anonaceae with the Myristicaceae, assigned *Eupomatia* to the latter family.

After 1912, botanists generally have followed Diels' lead, and among the supporters of this change are Engler and Gilg (12, 13), Hutchinson (22), Garratt (17), Lemesle (23), Bailey and Nast (1), Ozenda (27), Metcalfe and Chalk (25), and Gundersen (18). Of these authors, the systematists Engler, Hutchinson and Gundersen give the Eupomatiaceae a place close to the Anonaceae, while Garratt, Lemesle and Ozenda emphasize the anatomical differences between the two families and suggest a more distant connection.

## SUMMARY OF NOMENCLATURE

EUPOMATIACEAE Diels in Bot. Jahr. **48** (Beibl. 107): 7–13. 1912; Engler and Gilg in Syl. Pfl. 193. 1912 and 197. 1919; Hutchinson, Fam. Fl. Pl. Dicot. 88. 1926; Gundersen, Fam. Dicot. 63. 1950.

*EUPOMATIA* R. Brown in App. Flind. Voy. **2**: 597, *t. 2*. 1814.

**Eupomatia laurina** R.Br. in App. Flind. Voy. **2**: 597, *t. 2*. 1814.

**Eupomatia bennettii** F. v. Muell. in Muell. Fragm. Phyt. Austr. 1: 45. 1858; Hook. in Bot. Mag. **81**: *t. 4848*. 1855.

## GEOGRAPHICAL DISTRIBUTION OF EUPOMATIA

The family Eupomatiaceae occurs from eastern Gippsland, Victoria, to the Cape York peninsula, Queensland, and New Guinea. Along the eastern coast of Australia it is found on the comparatively narrow strip of land lying between the Dividing Range and the coast. In only a few places as at Murrurundi, New South Wales does *Eupomatia* grow as far inland as a hundred miles from the sea, but in several places as Shoalhaven River, Tenterfield, Tooloom Scrub, New South Wales, and Toowoomba, Queensland, it is found close to the Dividing Range. In New Guinea also, *Eupomatia* has been found in coastal or near coastal areas.

From the southern limit of its range near the Snowy River in Victoria, *Eupomatia* occurs more or less continuously along the coast of New South Wales in favorable situations which combine shelter, warmth (probably frost-free), moisture and good soil. Areas with these conditions are found usually at low altitudes in coastal gullies, along coastal rivers and on forested escarpments facing the sea. Here *Eupomatia* is found growing as an undershrub or small tree in the shade of a forest which may be called transitional between the sclerophyll forest of the drier slopes and the true rain-forest. The rarity of such favorable situations to the west of the Dividing Range probably accounts for the restriction of *Eupomatia* to the coastal side. In northeastern New South Wales and in Queensland *Eupomatia* may follow the transitional rain-forest up from the gullies on to the flanks and tops of mountains as in the Nightcap Range and Tooloom area of New South Wales, and the Lamington Plateau and other mountains near Brisbane. In the Cairns area, *Eupomatia* is found on the Atherton Tableland and in New Guinea most collections are from mountainous areas.

Of the two species of *Eupomatia*, only *E. laurina* extends to the full limits of this distribution. The range of *E. bennettii* falls within that of *E. laurina*, but it is restricted to northeastern New South Wales and Queensland. Within this section the two species apparently have an identical distribution.

The known localities for *E. bennettii* are indicated on the distribution map, Fig. 1,[1] as solid black triangles.

Between south-eastern Queensland and the Cairns area the known distribution of *Eupomatia* appears to be very intermittent with wide blank spaces. These blank spaces may be due partly to lack of intensive collecting in these areas but are mainly due to the intermittent occurrence of favorable habitat areas. The distribution of Australian rain-forests is discussed in detail by Francis (16) who points out that the moist rain-forest areas are interrupted by drier areas indicated by a predominance of *Eucalyptus* or *Acacia* spp. North of the Cairns area only one specimen was located which would justify including Cape York Peninsula within the range of *Eupomatia*. One would not expect to find *Eupomatia* in the savannah-forests of Cape York and the nearby Fly River valley of Papua but to be

[1] The map, Fig. 1, showing the distribution of *Eupomatia* is based partly on field observations in Australia and partly on specimens and information from the following herbaria:

| | |
|---|---|
| A | = Arnold Arboretum Herbarium, Harvard University, Cambridge, Mass. |
| BRI | = Botanical Museum and Herbarium, Brisbane, Queensland. |
| GH | = Gray Herbarium, Harvard University, Cambridge, Mass. |
| LAE | = The Papua and New Guinea Herbarium, Lae, New Guinea. |
| MEL | = Botanic Gardens and National Herbarium, Melbourne, Victoria. |
| NY | = Herbarium of the New York Botanical Garden, New York, N. Y. |
| SYD | = National Herbarium, Sydney, New South Wales. |
| SYD–U | = University of Sydney Herbarium, Sydney, New South Wales. |
| UC | = University of California Herbarium, Berkeley, California. |
| US | = United States National Herbarium, Washington, D. C. |

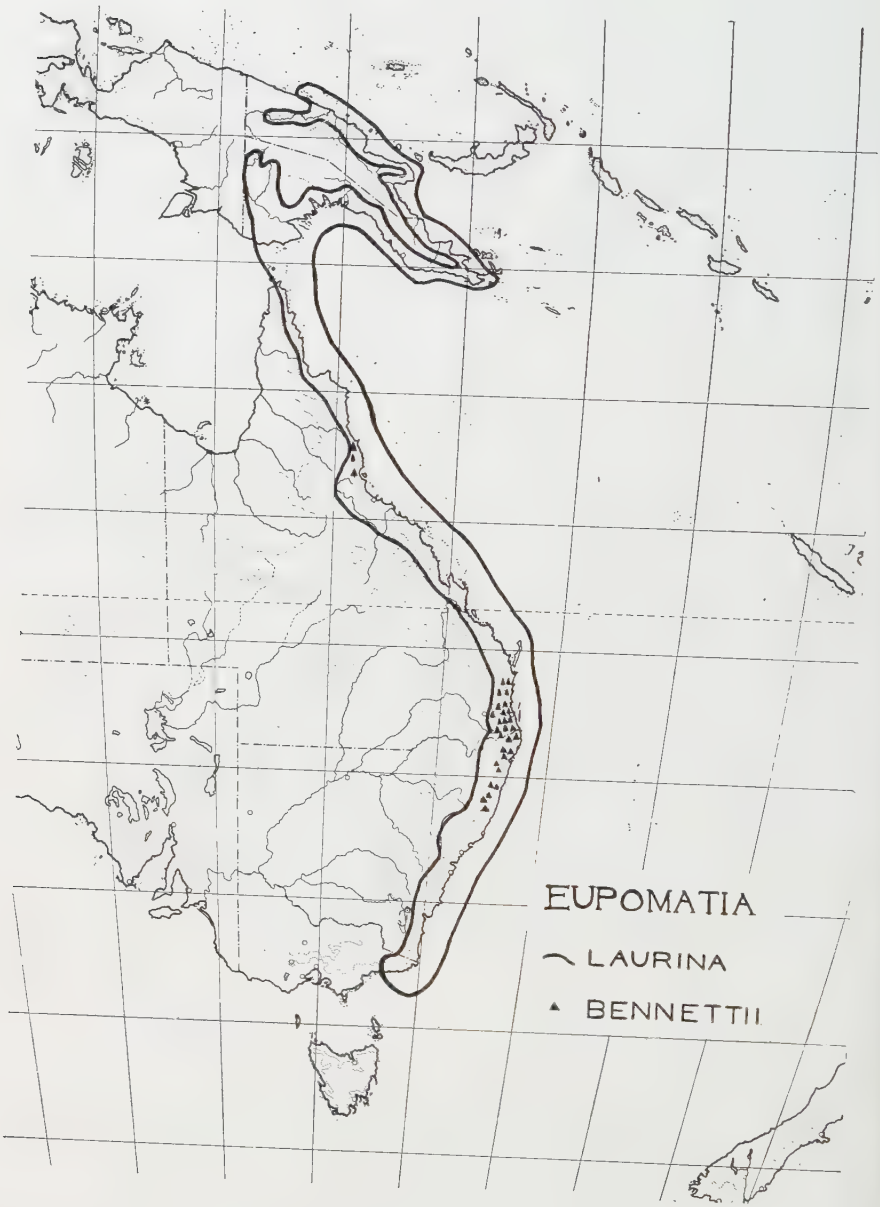



FIG. 1. Approximate known distribution of the genus *Eupomatia*. From Goode's series of base maps, no. 207.

rather widely distributed in the peripheral parts of New Guinea up to an altitude of about 1250 m. In commenting on his collection of *Eupomatia laurina* near Mt. Hagen in the Central Highlands of New Guinea, J. S. Womersley in a recent communication states, "I think it would be perfectly safe to assume that it is throughout the Sepik valley and all tributaries up to 4000 feet." Although there are apparently no records of *E. laurina* from Netherlands New Guinea, it may also be found there when collections from that area are more extensive.

While such a great north-south distribution (about 36°) is shared by a few other genera of Australasian angiosperms, hardly any species extend as far as *E. laurina*. *Hibbertia scandens* (*Hibbertia volubilis*) occurs in New Guinea and down the eastern coast of Australia to southern New South Wales but as this species is at once a member of the strand vegetation and also of the nearby rain-forest margins, its distribution is subject to a different explanation. Although this range for the species *E. laurina* is extensive in latitude, it is a relatively localized one for the genus which is quite restricted in both area and habitat when it is compared with such genera as *Drimys* and *Magnolia*. *Eupomatia* may be found in fairly close association with *Drimys insipida* in coastal gullies and (more rarely for *Eupomatia*) in the Blue Mountains of New South Wales, and again as on Mt. Glorious near Brisbane but not with the sub-alpine species *Drimys lanceolata*, *D. vickeriana*, *D. purpurascens* and *D. stipitata*. The difference in ecological situation can be seen distinctly at Barrington Tops, New South Wales. Here *Eupomatia* is found (with *D. insipida*) associated only with the rain-forest in the gullies at the base of the mountain while at the summit is found *D. purpurascens* associated with such plants as *Nothofagus* and *Gaultheria*. Between these two communities there is a broad zone of sclerophyll forest.

The distribution does indicate that the genus *Eupomatia* has moved across the Torres Strait region between New Guinea and Queensland sometime in the past, and its general ranalian affinities suggest that other more or less related families were doing the same thing at the same time. Under favorable climatic conditions, *Eupomatia* was able to push southward along the eastern coast of Australia until it reached the Southern Ocean. The present discontinuous populations probably represent contractions to smaller areas from a formerly continuous population due to changes in climatic conditions. Crocker and Wood (7), Herbert (19, 20) and others have surveyed the geological history and its consequences on the Australian flora.

In the present case, other evidence such as established close relationships with other families, or evidence from fossils, is vague or lacking. A parallel can be seen in the distribution of the small monogeneric ranalian family Himantandraceae, which is found in Queensland and in New Guinea as well as in the Moluccas. Of interest in this connection also are the conclusions and suggestions of A. C. Smith (29) as to the center of origin of the Winteraceae, in pointing to the Queensland-New Guinea area as an ancient home of ranalian plants.

FIG. 2. *Eupomatia bennettii* F. v. Muell. Mature plant showing single, terminal, young fruit and tuberous roots. The dead stubs indicate the position of the fruit in previous years. Near head of small gully, near Bellingen, N.S.W. *A. T. Hotchkiss 108*, Sept. 3, 1954.

FIG. 3. *Eupomatia laurina* R. Br. Small branch showing flower buds terminal on axillary short shoots about 1 month pre-anthesis. On moist escarpment, Bulli Pass, N.S.W. *A. T. Hotchkiss 196*, Nov. 27, 1954.

The two species of *Eupomatia*, although very distinct, have strong family characters in common. Both have the same number of chromosomes (N = 10). Of the two species neither is more primitive in all its features, i.e. some of the morphological details of *E. bennettii* seem to be less specialized than the corresponding form in *E. laurina*. A plant of *E. bennettii* for example usually has but a single flower terminal on the main stem. FIG. 2. *Eupomatia laurina*, with smaller flowers, terminal on axillary short shoots, is more specialized in its inflorescences, FIG. 3. On the other hand the tuberous, small (30–60 cm.) shrub *E. bennettii* has the more specialized habit when compared with *E. laurina* which is often a small tree up to 15 m. high. Thus neither should be regarded as being derived directly from the other but rather both species could have been derived from an unspecialized, common ancestor.

Variation within the species is more pronounced in *E. laurina*. A question arises here as to whether *E. laurina* is indeed one and the same species at both north and south extremes of its range. A preliminary comparison of the specimens from the northern Queensland and New Guinea area seems to indicate that they are distinct from the southern population. These differences are found in the leaves, flower buds, flowers and fruits. In the northern population the leaves may be 1.5 to 2 times longer; the flower buds are somewhat larger than the fruits in the southern population, are more nearly spherical, with a slightly elevated calyptra apex (which is conical in southern specimens), and with a more distinctly elongate base below the floral organs; the flowers may have twice as many stamens and staminodes; carpel number has not been determined. Further detailed investigation of the New Guinea material is needed.

In *E. bennettii* variations occur in the size and form of the leaves which range in form from narrow-lanceolate to rhomboidal. But since all these variations have been observed in the offspring of a single plant they are of minor importance.

Both species of *Eupomatia* occur in New South Wales and Queensland while *E. laurina* extends southward to Gippsland and northward to New Guinea. The region with the greatest number of species might be considered to be the specific center of origin for the genus. But it should be remembered that both species are in some features relatively specialized and derivative and that both species have the same northern limits in Australia and proximity to New Guinea. It would probably be better to consider *Eupomatia* as an element of general Malaysian affinities which has entered Australia and continues to find there suitable ecological niches which give it a somewhat relic distribution along the eastern coastal area.

### 1. Eupomatia bennettii F.v. Mueller

DISTRIBUTION: New South Wales; Queensland.

NEW SOUTH WALES: Tirralong, via Bowraville, *G. Garratt* (SYD), 1930. — Bellingen, heads of small ravines, *A. Hotchkiss* (SYD-U), Aug. 15, 1953. — Bellingen-Dorrigo road, in timber, *A. Hotchkiss* (SYD-U), Aug. 14, 1953. — Cor-

amba, near Coffs Harbour, *E. Thornton* (MEL), Aug. 8, 1884. — Ulong, half-way from Glenreagh to Dorrigo, *W. Heron* (SYD), 1920. — Clarence River, *E. Betche* (SYD); *H. Beckler* (MEL). — Alstonville, *D. H. Tomlins* (SYD), 1912; (drawing of roots and tubers, SYD). — Richmond River, *F. v. Mueller* (SYD); *Mrs. Hodgkinson* (MEL), 1878. — Tweed River, *W. Guilfoyle* (MEL), 1871; Tweed River, Stokers Siding, *Bray* (SYD), 1937.

Queensland: Beechmont, *K. Scott* (BRI), 1937. — Springbrook, *A. Salmon* (BRI), 1929. — National Park, MacPherson Range, *A Hotchkiss* (SYD-U), June 1953. — Tambourine Mountain, *C. T. White 3569* (A), Aug. 17, 1927; Ibidem, *C. T. White* (BRI), 1916. — Kilcoy, *C. England* (BRI), 1921. — Kelvin Grove, near Brisbane, *J. Shirley* (BRI). — Yandina, *T. P. Keys* (BRI), 1920. — Toowoomba, *C. I. Gwyther* (BRI), 1930. — Moreton Bay, *F. v. Mueller* (type, MEL), July 1855. — Mt. O'Reilly, near Brisbane, *D. A. Goy* (BRI), 1938. — Montville, *J. Shirley* (BRI). — Eumundi, *J. H. Simmonds* (BRI), 1892; *F. M. Bailey* (BRI). — Gold Creek, near Brisbane, *C. T. White* (BRI), 1915. — Nambour, *E. V. McKieg* (BRI), 1930. — Archer's mountain brush, *L. Leichhardt* (SYD), 1843. — Johnstone River, *C. Palmerston* (MEL). — Dalrymple Gap, near Rockingham Bay, *J. Dallachy* (MEL), June 11, 1864. — Danbulla, Atherton Tableland, *L. Smith* (BRI). — Between Cairns and Herberton, *C. J. Wild* (BRI), 1891.

## 2. Eupomatia laurina R. Brown

Distribution: Victoria, New South Wales, Queensland, New Guinea.

Victoria: Lower Snowy River, *R. P. Cameron* (MEL), 1895. — Snowy River, *H. B. Williamson* (SYD). — Mt. Buck, near Orbost, *E. E. Pescott* (MEL), Feb. 1901. — Orbost, *J. Rowe* (MEL), 1903. — W. Buck, Gippsland, *C. Walker* (SYD), 1901. — Brodrible River, east Gippsland, *C. Walker, E. Pescott* (SYD), 1900. — Wingan and Genoa River (MEL). — Howe Ranges, ca. 2 miles s.e. of Marshmead Homestead on east shore of Mallacoota Inlet, *J. H. Willis* (MEL), Oct. 24, 1948.

New South Wales: Eden, *E. Cheel* (SYD), 1903; *B. Pigott* (SYD), 1931. — Twofold Bay, *F. v. Mueller* (MEL), Sept. 1860; *L. Morton* (MEL). — Tilba Tilba, *E. Reader* (MEL), Jan. 29, 1880. — Mt. Dromedary, *E. Reader* (MEL), Aug. 3, 1880. — Brogers Creek, near Braidwood, *W. Bauerlen* (MEL). — Milton, *R. H. Cambage 4064* (SYD), 1913. — Shoalhaven River, *F. A. Radaway* (SYD). — Bundanoon, alt. 600 m., *E. F. Constable 11305* (SYD, US), Jan. 6, 1950. — N. end of Kangaroo Valley, 17 miles from Moss Vale, *R. V. Smith* (MEL), Jan. 28, 1953. — Minnamura Falls, *L. Johnson, H. K. Judd* (SYD), 1953. — Kiama, *W. H. Harvey* (MEL, NY, GH), Jan. 1856. — W. Dapto, *R. H. Cambage* (SYD), 1901. — Mt. Kembla, *A. Hamilton* (SYD). — Bulli, *S. Johnson* (MEL), 1875; *E. Cheel* (SYD), 1900; *A. Hotchkiss* (SYD-U), 1953. — Kissing Point, west of Gladesville, *W. Woolls* (MEL). — North Clifton, *J. J. Fletcher* (SYD), 1893. — Brush Forests, *W. Hudson* (SYD), 1914. — Botany Bay, *G. Caley* (US), Dec. 1804. — New South Wales (no specific locality), *G. Caley* (A), Dec. 29, 1807. — Port Jackson, *R. Brown 4921* (type, MEL), 1802–1805; no collector (BRI). — North Rocks, Parramatta, *W. Woolls* (MEL). — Blue Mountains, west of Sydney, *L. Atkinson* (MEL), ca. 1860. — Sassafras Gully, Springwood, *A. Hotchkiss* (SYD-U), 1953. — Fox Ground, Kurrajong, (collector not given, MEL). — Barrenjoey Island, Broken Bay, *J. Vickery* (SYD), 1946.

— gully near Gosford, *A. Hotchkiss* (SYD-U), July 1954. — 4 miles south of Newcastle (MEL), Dec. 1862. — Crawford River, north of Bulladelah, *E. Cheel* (SYD), 1902. — Tailford to Forster, *J. H. Maiden* (SYD), 1896. — Upper Williams River, near Barrington Tops, *L. Fraser & J. Vickery* (SYD), 1934; *A. Hotchkiss* (SYD-U), Jan. 1954. — Gloucester, *E. Betche* (SYD, MEL), 1882. — Murrurundi, *J. H. Maiden & J. L. Boorman* (SYD), 1902. — Black Creek, near Kendall, *T. Waite* (SYD), 1950. — Kendall, *F. M. Bailey* (SYD), 1929. — Combogne, *E. C. Chisholm* (SYD), 1923. — Port Macquarie, *J. H. Maiden* (SYD), 1897; *H. Beckler* (MEL). — Andersons Sugar Loaf, *J. L. Boorman* (SYD), 1909. — Gleniffer, Bellingen River, *E. Swain & A. Forester* (SYD), 1910. — Bellingen River (MEL); Bellingen River, Bellingen, *A. Hotchkiss* (SYD-U), August 1953. — Coffs Harbour, *J. L. Boorman* (SYD, UC), May 1909. — Bucca Creek, *J. L. Boorman* (SYD), 1912. — Coramba, *J. L. Boorman* (SYD), 1912. — Glenreagh, *A. W. Livingstone* (SYD), 1945. — Clarence River, *J. F. Wilcox* (MEL), Nov. 1875. — Demon Creek, east of Tenterfield, *C. Stuart* (MEL), ca. 1860. — Drake, *J. Richards* (SYD), 1913. — Casino, *D. J. McAuliffe* (SYD), 1913. — Shannon Brook, Casino, *G. Simkins* (SYD), 1914. — Richmond River District, *C. Fawcett* (MEL). — Bangalow, *W. Bauerlen* (SYD), 1896. — Byron Bay, *J. H. Maiden & J. L. Boorman* (SYD), 1903. — Nightcap Range, *A. Hotchkiss* (SYD-U), June 1953. — Beaury State Forest, *C. T. White 12845* (BRI), May 29, 1945; *C. T. White 12843* (A), May 29, 1945. — Tooloom, *A. Hotchkiss* (SYD-U), Dec. 1953. — Between Urbenville and Legume, *A. Hotchkiss* (SYD-U), Dec. 1953. — Tweed Heads, *J. L. Boorman* (SYD, US), Jan. 1914. — Terranara, Tweed Heads, *F. J. Davey* (photo of flowers, SYD), 1906. — Acacia Creek, *W. Donn* (SYD), 1906. — Robbinsville, *R. T. Baker* (US), 1891.

Queensland: National Park, MacPherson Range, *Tryon & White* (A), March 1920; *A. Hotchkiss* (SYD-U), June 1953. — near Emu Vale, MacPherson Range, *W. D. Francis* (BRI), 1920. — Christmas Creek, *D. A. Goy* and *L. Smith 314* (A, BRI), 1938. — Mt. Tamborine, 45 miles s. of Brisbane, alt. 1,800 ft., *C. E. Hubbard 2504* (BRI), May 5, 1930; *J. Shirley* (A); *C. T. White 1772*, (A), Dec. 1921. — Toowoomba, *Hartman* (MEL), 1882. — Laguna Bay, *Eaves* (MEL). — Mt. Glorious, *A. Hotchkiss* (SYD-U), June 1953. — Mistake Mountains, Moreton District, *L. Smith* (BRI), 1948. — Enoggera Creek, *F. v. Mueller* (BRI), 1874; *C. T. White* (BRI), 1914; *F. M. Bailey* (US). — Brisbane River, *F. v. Mueller* (MEL), July 1855. — Brisbane, *Griffith* (MEL). — Pine River, Moreton Bay, *E. Fitzalan* (MEL). — Blackall Range, *C. I. Gwyther* (A), Jan. 1920; *C. T. White* (A), Dec. 1916. — Peeramon, *E. W. Bick* (BRI), 1913. — Palmwoods, *C. T. White* (BRI), 1907. — Gympie, *F. H. Kenny* (BRI), 1907. — Kin Kin, *F. White* (BRI), 1916; *W. T. Francis* (UC), Dec. 1919. — Fraser Island, *C. E. Hubbard 4655* (BRI), Oct. 17, 1930. — Eungella Range, *W. D. Francis* (BRI), 1922; *C. T. White* (BRI), 1938. — Rockingham Bay, *J. Dallachy* (MEL), Feb. 17, 1864, April 13, 1864, Oct. 19, 1864, Sept. 1867, Oct. 28, 1870. — Herbert River, *Eaton* (BRI). — Herberton Range, Scrubby Creek, alt. 600 m. *S. F. Kajewski 1360* (A, NY, BRI), Nov. 14, 1929. — Innisfail, *N. Michael 411* (BRI). — Johnstone River, *H. G. Ladbrook* (BRI), 1917. — Russell River, *W. Sayer* (MEL), 1886, 1887. — Atherton Tableland, *C. T. White* (A, BRI), Jan. 1918. — Kamerunga, *E. Cowley* (BRI), 1892. — Jarra Creek, N. E. Queensland, *A. G. Hanson* (BRI), 1948. — Daintree River, *E. Fitzalan* (MEL), 1876. — Bloomfield River, *W. Bann* (or *Hann*?) (MEL), 1884.

New Guinea: Western Division: Tarara, Wassi Kussa River, common in light rainforest, *L. J. Brass 8658* (A, LAE), Jan. 1937. Gulf Division: The Cupola, alt. 800 ft., *L. J. Brass 1362* (A), Jan. 4, 1926. Central Division: Mafulu, forest regrowths, alt. 1250 m., *L. J. Brass 5218* (A, NY, BRI), Sept.–Nov. 1933. — Sogere, near Port Moresby, *H. O. Forbes 551* and *547* (MEL), 1885–1886. — Astrolabe Range, *C. T. White* (BRI), 1918. — South East New Guinea (Division?): *J. Chalmers* (MEL), 1885. Morobe Division: Morobe, alt. 3300 ft, *M. S. Clemens 1975A* (A), March 11, 1936. — Kaile, Ogeramnang, alt. 5000 ft., *M. S. Clemens 5793* (A), April 17, 1937. — Kulungfufu, alt. 5300 ft., *M. S. Clemens 6527* (A), June 7, 1937. — Busu River, near Lae, *N. G. F. 5503* (LAE), Feb. 14, 1954. Northeast New Guinea: Baum in den Wäldern am Kaulo, etwa 300 m. ü., blühend, *R. Schlechter 16870* (UC, also cited by Diels, Bot. Jahr. **49**:165, 1913), Nov. 22, 1907. Central Highlands Division, T.N.G.: Baiyer River, near Mt. Hagen, alt. 4000 ft., *N. G. F. 6799* (LAE), Nov. 25, 1954.

I am indebted to the directors and keepers of the herbaria listed, for their help in assembling information on distribution, and especially to the directors and staffs of the herbaria which I have visited, for the hospitality offered. Special thanks are due to Mr. W. D. Francis, Government Botanist, and Mr. L. S. Smith, Botanist, of the Brisbane Herbarium; to Mr. L. Webb, Plant and Soils Regional Laboratory, C.S.I.R.O., Brisbane; and to Dr. G. Hewitt, Dr. M. Elliott and Mr. B. Rickerby of Bellingen, New South Wales, for their kind help in getting me into the field to make collections; and to Mr. J. S. Womersley, Department of Forests, Lae, New Guinea, for his very helpful observations on the distribution of *Eupomatia* in the Territory of Papua and New Guinea.

## LITERATURE CITED

1. Bailey, I. W. and C. G. Nast. The comparative morphology of the Winteraceae I. Pollen and stamens. Jour. Arnold Arb. **24**: 340–346. 1943.
2. Baillon, H. Recherches organogeniques sur les *Eupomatia*. Adansonia. **9**: 22–28. 1868–1870.
3. Bartling, F. G. Ordines naturales plantarum. 1830.
4. Bentham, G. and J. D. Hooker. Genera Plantarum. **1**: 28–29. 1862.
5. Brown, R. General remarks, geographical and systematical on the botany of Terra Australis. Appendix III, **2**: 597, *t. 2.* in Flinders, M. A voyage to Terra Australis. 1814.
6. ———. Misc. Botanical Writings. Ray Society. **1**: 74. 1866.
7. Crocker, R. L. and J. G. Wood. Some historical influences on the development of the South Australian vegetation communities and their bearing on concepts and classification in ecology. Trans. Roy. Soc. S. Aust. **71**: 91–136. 1947.
8. Diels, L. Über primitive Ranales der australischen flora. Bot. Jahr: **48**(Beibl. 107): 7–13. 1912.
9. ———. Die Anonaceen von Papuasien. Bot. Jahr. **49**: 165. 1913.
10. Endlicher, S. Genera Plantarum. p. 835. 1839.
11. Engler, A. Syl. Pflanzenf. p. 135. 1909.
12. ——— and E. Gilg. Syl. Pflanzenf. p. 193. 1912.
13. ——— and ———. Syl. Pflanzenf. p. 197. 1919.

14. ENGLER, A. AND K. PRANTL. Naturl. Pflanzenf. III. **2:** 39. 1891.
15. ——— AND ———. Naturl. Pflanzenf. Nachtr. **II:** 115. 1908.
16. FRANCIS, W. D. Australian rain-forest trees. 1951.
17. GARRATT, G. A. Bearing of wood anatomy on the relationships of the Myristicaceae. Trop. Woods. **36:** 20–44. 1933.
18. GUNDERSEN, A. Families of Dicotyledons. p. 63. 1950.
19. HERBERT, D. A. The relationships of the Queensland flora. Proc. Roy. Soc. Qld. **44:** 2–22. 1932.
20. ———. The climatic sifting of the Australian vegetation. Rep. A. N. Z. A. A. S. Melbourne. p. 349–370. 1935.
21. HOOKER, W. J. Curtis's Botanical Magazine. **81:** *t. 4848*. 1855.
22. HUTCHINSON, J. Families of Flowering Plants. Dicots. p. 88. 1926.
23. LEMESLE, R. Les vaisseaux à perforations scalariformes de l'*Eupomatia* et leur importance dans la phylogénie des Polycarpes. C. R. Acad. Sci. Paris. **203:** 1538–40. 1936.
24. MEISNER, C. F. Genera Plantarum. p. 4 (6). 1836–1843.
25. METCALFE, C. R. AND L. CHALK. Anatomy of the Dicotyledons. **1:** 50–51. 1950.
26. MUELLER, F. v. Fragmenta Phytographiae Australiae. **1:** 45. 1858.
27. OZENDA, P. Structure du noeud foliaire des Magnoliacées et des Anonacées. C. R. Acad. Sci. Paris. **224:** 1521–3. 1947.
28. SMITH, A. C. A nomenclatural note on the Himantandraceae. Jour. Arnold Arb. **23:** 366–368. 1942.
29. ———. Geographical distribution of the Winteraceae. Jour. Arnold Arb. **26:** 48–59. 1945.

UNIVERSITY OF SYDNEY,
SYDNEY, AUSTRALIA.

# FURTHER NOTES ON THE WEEDS AND INTRODUCED PLANTS OF FIJI

WILLIAM GREENWOOD

THE NOTES HERE PRESENTED terminate those I have accumulated during 35 years of residence in Fiji, during which much of my spare time was devoted to collecting and studying plants. Other papers in this series have appeared in Proc. Linn. Soc. **154**: 92–106. 1943, and in Jour. Arnold Arb. **25**: 397–405. 1944, and **30**: 75–84. 1949.

In his paper on "The Vegetation and Flora of Fiji" (in Sci. Monthly 73(1): 3–15. 1951), A. C. Smith gives the number of adventive species (weeds, escapes, etc.) in Fiji as 529, and of indigenous species as 1266. This number of adventive species, however, is drawn from all the published records. I feel sure that when the synonymy has been completely checked, and when the species that did not persist have been excluded, this number will be greatly reduced. From my own records I should put the number of adventive species at about 380, or approximately 18 per cent of the total phanerogam flora.

As in my previous papers, families are discussed in the order of Bentham & Hooker's Genera Plantarum. Collection numbers found in the text italicized in parentheses refer to the writer's specimens; these are inserted only when the species has not previously been reported from Fiji.

I was impressed in Fiji by the manner in which a new introduction will increase rapidly for a few years until it covers acres of waste land, to the exclusion of most other plants, subsequent to which it will gradually die down and become no more abundant than dozens of other introductions. This was particularly noticeable among the grasses, which came in, increased rapidly, and then decreased in significance, to be replaced by another grass. Many of the weeds recorded from Fiji on the basis of one or two collections are probably no longer to be found there, and the place of these in lists of the flora is questionable.

## NYMPHAEACEAE

**Nymphaea capensis** Thunb. (probably)

Waimaleka Creek, near Sambeto, Lautoka District, Mba, Viti Levu (*1306*). This blue-flowered water-lily has been growing in parts of the Lautoka and Nandi Districts for the past 20 years and is quite naturalized. It was probably introduced years ago, since which it has escaped and spread. It is periodically removed from Waimaleka Creek, as its growth hinders the flow of water and tends to cause flooding in nearby sugar-cane lands.

**Nymphaea capensis** Thunb. var. **rosea** Hort. (probably)

Swamps near Nandi, Nandi District, Mba, Viti Levu (*1307*). This pink-flowered variety is not as common as the preceding, but it has been quite naturalized in the cited locality for at least ten years.

MALVACEAE

**Gossypium** spp.

In Flora Vitiensis (pp. 21, 22. 1865), Seemann discussed *G. peruvianum* Cav., *G. barbadense* L., and *G. arboreum* L. (with *G. herbaceum* L. as a synonym) as being naturalized in Fiji. They do not appear to have survived, as I have never seen them or heard reports of them in recent years. I believe they should be removed from modern lists of the flora of Fiji.

**Sida acuta** Burm. f.

In attempting to establish the date of this introduction (in Jour. Arnold Arb. **30**: 76. 1949), I remarked that *Greenwood 99* appeared to be the earliest collection, but I neglected to mention the date of this as 1919.

ZYGOPHYLLACEAE

**Tribulus terrestris** L.

This species is mentioned as occurring in Fiji in Agr. Jour. Dept. Agr. Fiji **11**(2): 51. 1940. However, I have never found it nor heard of its collection by recent field workers. The occurrence of *T. cistoides* L. is more to be anticipated in Fiji.

LEGUMINOSAE

**Cassia leschenaultiana** DC.

This plant is becoming common in the Mba and Tavua Districts of Viti Levu, and it has also recently been noted in the Nandi and Singatoka Districts.

MELASTOMATACEAE

**Clidemia hirta** (L.) D. Don

This weed has become fairly common around the edges of clearings in parts of the Mt. Evans Range region, Mba, Viti Levu, at elevations between 2000 and 2500 feet.

CUCURBITACEAE

**Coccinea cordifolia** (L.) Cogn.

The bright red fruits of this creeper are used by the Indians in Fiji in making curries.

COMPOSITAE

**Eleutheranthera ruderalis** (Sw.) Sch.-Bip.

Noticed in waste places around Suva, Viti Levu, in March, 1951.

**Erigeron sumatrensis** Retz.

This is the species which in earlier papers I discussed as *E. floribundus* (H. B. K.) Sch.-Bip. Some of the specimens referred to *E. albidus* A. Gray may prove to represent *E. sumatrensis*.

BORAGINACEAE

**Cynoglossum amabile** Stapf & Drummond

Commonly grown in European gardens in Fiji and evidently recently escaped in the vicinity of Nandarivatu, where Smith collected it in 1947 (cf. Jour. Arnold Arb. 33: 116. 1952).

ACANTHACEAE

**Thunbergia grandiflora** Roxb.

The inclusion of this species in the Fijian flora is questionable, as I feel fairly certain that the locality of Degener's collection in Ra (cf. Sargentia 1: 117. 1942) used to be a garden attached to the District Commissioner's house. Because of its attractive flowers this creeper is commonly grown in European gardens throughout Fiji, but I have never seen or heard of it setting fruit.

**Asystasia gangetica** (L.) T. Anders.

The seeds of this plant are sought after and eaten by domestic fowls in Fiji.

EUPHORBIACEAE

**Euphorbia** cf. **australis** Boiss.

This species, of which the precise identity still remains uncertain (cf. Jour. Arnold Arb. 25: 402. 1944), has now spread from Singatoka to the Lautoka District.

**Euphorbia drummondii** Boiss.

This species became established on the Colonial Sugar Refining Company's tennis courts at Lautoka, Viti Levu, in 1942. These courts are kept under couch grass (*Cynodon dactylon* Pers.) and are rested each year during the wet season, from about the end of the year until the end of April. By March, 1943, the *Euphorbia* had covered about one quarter of the courts, and in some places it had completely killed the couch grass in patches up to two feet in diameter. As it spreads close to the ground, the regular mowing had no effect on it, and it was necessary to dig up the plants by hand.

HYDROCHARITACEAE

**Hydrilla verticillata** (L. f.) Royle

During the dry season, when the Nandi River is low, horses wade out into the river and feed on this species, which was first reported from this locality by me in Jour. Arnold Arb. 25: 403. 1944.

## GRAMINEAE[1]

**Andropogon nodosus** (Willem.) Nash

At sea-level, Lautoka, Mba Province, Viti Levu (*1223*). This species was first noticed about 1950, often at the sides of drains and in other wet places.

**Chloris inflata** Link

At sea-level, Lautoka, Mba Province, Viti Levu (*1213*). The species also occurs in the vicinity of the Nandi airport, in the present Mba Province.

**Eriochloa procera** (Retz.) C. E. Hubbard

Noticed at sides of roads and in waste places around Suva in March, 1951.

**Dactylis glomerata** L.

This species was originally recorded, as to its Fijian occurrence, from Nandarivatu, Mba Province, Viti Levu, but during various visits there I have never seen it. If its persistence is not indicated by recent collections, it should perhaps be omitted from the lists of the Fijian flora.

**Bambusa** sp.

The common bamboo in Fiji grows beside creeks and rivers at elevations up to 2000 feet. It is used by the Fijians for rafts, house-building, and numerous other purposes. It is included here because it can be a nuisance. In the wet season, when the Rewa and Singatoka Rivers are liable to flood, clumps of this bamboo growing on the river-banks are undermined and fall into the rivers. They are carried down and, because of the length of the culms (often 60 feet), lodge across the piers of bridges downstream. This causes debris to pile up against the bridges and holds the water back, threatening damage to the piers and superstructures. In such cases it has been necessary for workmen to cut the lodged bamboo culms. To avoid this situation, each year about September workmen are employed to work up the rivers and cut down any large bamboos growing on the banks.

During thirty years of residence on the northern coasts of Viti Levu I have never seen this bamboo in flower and so have never been able to collect material adequate for specific identification. I am told that it flowers frequently on the wet side of Viti Levu.

This species is planted beside tracks by the Fijians for shade, and often on the tops of hills as well. I believe that when so planted it is intended to show the route of a track, as I know of a number of cases where, on coming to the top of a ridge with its clump of bamboos, one can look out and see another clump on a ridge three or four miles away, which one will find to be also beside the track.

[1] Two of the grasses listed here are first reported from Fiji, as indicated by my collection numbers. I am indebted to Dr. Jason R. Swallen for identifications of my recent grass collections.

The species has been in Fiji at least fifty years, and probably longer. I regard it as introduced, possibly from India, by Indians when they first came to Fiji.

I am indebted to Mr. Walter Freeman, of the Colonial Sugar Refining Company, who lived for many years along the Rewa River, for much of the above information.

Waitara, Sydney,
Australia.

# THE DIRECTOR'S REPORT

## The Arnold Arboretum during the Fiscal Year ended June 30, 1955

On July 1, 1954, the start of the fiscal year, the staff of the Arnold Arboretum was actively engaged in the process of moving the non-horticultural specimens and books from its herbarium and library and its non-horticultural activities to the Harvard University Herbarium in Cambridge. The background for this move was reviewed in the Annual Report for the year 1953–54 (Jour. Arnold Arb. 35: 367–381. 1954). Before the move was attempted, the facilities and activities in horticulture which continue to be centered in the Administration Building in Jamaica Plain were reorganized. The books to remain in Jamaica Plain, forming the horticultural library, were segregated. Herbarium specimens needed for the study of plants under cultivation in the living collections of the Arboretum and elsewhere were organized into a unit located on the main floor of the Administration Building.

The actual moving of specimens and books to Cambridge was completed on July 9th. Plans were then completed for the proper utilization of the Administration Building in Jamaica Plain and a contract was signed for alterations in that building. The improvements were finished in late October. The changes are many and represent a new unit of greater usefulness and efficiency both for the staff of the Arboretum and the general public who wish to consult the horticultural herbarium or library or to take part in the activities of the Arboretum. The horticultural library has been established on the first floor in the front part of the building. A spacious reading room, attractively decorated, is lined with steel shelves for volumes and folios. New fluorescent lighting makes this a pleasant room for library purposes. Additional steel stacks were erected on the second floor for the periodicals applicable to horticulture. Three new offices for the director, the horticulturist and the horticultural secretary open off the library reading room. These rooms supply private offices for these staff members for the first time. The convenience of this business office on the first floor and adjacent to the front door has received the compliments of the many visitors who apply for driving permits and who formerly had to climb a flight of stairs. The front hall has been completely redecorated with new display cases for Arboretum publications and flowering displays. New kodachrome prints of flowering shrubs and trees of the Arboretum have been arranged on the walls.

The other large room in the front part of the building on the first floor has been redecorated and functions both as a lecture hall and a demonstration room. For lectures it is used for some of the education classes conducted by the staff and for meetings of garden clubs and similar groups in connection with Arboretum activities. Such a room has been sorely needed

by the Arboretum for the proper demonstration and conduction of its activities in the field of horticulture. A generous gift from Mr. Godfrey Cabot helped finance the alterations in this room, which is attractively decorated in a light gray-green color with deep crimson draw curtains. It has been approved by officials of the City of Boston as a meeting place for audiences of 100 to 150 persons. It is our desire to maintain this room as a flexible space; hence folding chairs, movable tables and partitions enable the room to be used for lectures, classes and exhibitions. The continuous use of this room by individuals and groups interested in the horticultural work of the Arboretum has proved its value.

FIG. 1. The Harvard University Herbarium in Cambridge, Massachusetts, which houses a portion of the collections of the Arnold Arboretum, the Gray Herbarium, the Orchid Herbarium and Library of Oakes Ames, the University Paleobotanical Collections and is adjacent to the Farlow Herbarium and library. The non-horticultural activities of the Arnold Arboretum were transferred to this building during the summer of 1954.

By the removal of the non-horticultural activities to Cambridge, the Administration Building has gained space for current and future activities. Space in the basement formerly used for the storage of herbarium specimens has been turned over to the grounds crews and redecorated for locker rooms and lunch space. The upper floors of the herbarium wing are used in part

FIG. 2. Top. The new library reading room for horticulture in the Administration Building of the Arnold Arboretum in Jamaica Plain. Three offices open off the left of the reading room. Additional library stacks are located in the rear of the Administration Building.

FIG. 2. Bottom. A portion of the lecture and demonstration room recently created at the Administration Building in Jamaica Plain. Ektachrome display panels are visible on the lecture platform. A portion of the pruning exhibit held in the spring of 1955 is seen at the left. Comfortable folding chairs are available for seating 150 persons.

for active library stack area, particularly periodicals, in part for library storage and in part for storage of unworked herbarium specimens accumulated over the past twenty years. These specimens represent horticultural as well as non-horticultural species and the collections are from China, India, Indo-China, Burma and countries of South America. As staff time permits, these collections will be identified, specimens added to the horticultural or the non-horticultural herbarium and duplicates distributed to other organizations. This accumulation of unworked material represents a sizable investment of Arboretum funds and will involve several thousand hours of professional staff time before the study of them is completed.

Three staff members retain offices on the upper floors of the building. The rooms formerly occupied by the library are empty at the present time and available for increases either in the staff or the horticultural activities of the Arboretum.

Concomitant with the establishment of distinct and organized resources for the field of horticulture, the Arboretum has been able to establish a firmer foundation for the work of its staff in the study of plants not under cultivation and in the native floras of the world. The non-horticultural specimens and books moved to Cambridge, now properly housed in Cambridge in steel cases in a dust-free building under controlled environmental conditions of humidity and temperature, are available for more efficient use by the staff of the Arboretum and by professional colleagues at Harvard and elsewhere. The relatively short distance between the Arboretum's horticultural collections at Jamaica Plain and its non-horticultural collections in Cambridge allows easy interchange of materials and ideas. In Cambridge the Arnold Arboretum's collections are housed for the first time in the same building with the Arboretum's wood and pollen slide collections, the Gray Herbarium, and the paleobotanical collections; and these are adjacent to the excellent facilities of the Museum of Comparative Zoology, the Botanical Museum and the Biological Laboratories. Already these combined and adjacent collections have proved mutually advantageous and useful to Arboretum staff members, as well as to those of the other institutions and to visiting botanists. The Arboretum's books and specimens are being used more than ever before, to the benefit of all.

With the completion of the physical rearrangements in Jamaica Plain, the majority of the herbarium staff turned its attention to the collections of specimens and books which had been moved to Cambridge. The Gray Herbarium had completed its move before any materials were removed from Jamaica Plain. The books of the Gray Herbarium had all been placed on steel shelving occupying one side of the library stack area. Before the books of the Arboretum were transferred to Cambridge they were all carefully catalogued and each book, pamphlet, folio volume or reprint was properly identified with an embossed seal of the Arnold Arboretum on the fly leaf and on several selected pages in the volume. The inner cover face bore a bookplate of the Arnold Arboretum and labeled on the back of many of the books was the inscription, "Library of the Arnold Arboretum." All books as they are bound or rebound are to be so inscribed. Pamphlets and

similar items bear or will bear an adhesive sticker with the same inscription. The books were arranged on the steel shelves of the other half of the library stack area in the same arrangement which they previously had. Folio volumes are located on special steel folio shelves at one end of the library stack area and are retained in a horizontal position. During the months which have elapsed since the completion of the move of those books to Cambridge, primary attention has been given to correct cataloguing and to the condition of the books. Already we can notice improvement in the condition of the books under the controlled humidity and temperature. Bindings treated in the usual library fashion are holding up better than before.

In planning the moving of the herbaria of the Gray Herbarium and the Arnold Arboretum, it was decided to incorporate the two collections in one phylogenetic sequence based on a modified Engler-Prantl system of classification. This was the system previously used by both herbaria. The adoption of a single sequence instead of maintaining two independent herbaria in the one building was based on our future plans for integration of the two collections. As the Gray Herbarium moved first, the cases holding herbarium specimens from that institution were spaced on the floors to house the total herbarium. The 440 new herbarium cases purchased for the building were also spaced in a general floor plan. The herbarium specimens of the Arnold Arboretum previously stamped on each sheet with the seal of the Arnold Arboretum were moved in their cases or in the cardboard boxes which housed these specimens in Jamaica Plain. The specimens in steel cases were interpolated in available space in the new building near the same families of the Gray Herbarium sequence. The specimens in the smaller cardboard boxes were placed on top of the new and empty cases in the approximate proper location in the sequence. The planning was almost one hundred per cent perfect. With the cases in place, each case was carefully aligned and wedged for proper fit with adjacent cases and for proper function and seal. Felts were replaced on nearly all the cases. These felts had been treated with insecticide and each case was reexamined and determined to be insect-free or was fumigated immediately.

During the remainder of the fall and winter months, some of the herbarium staff worked continuously to incorporate those herbarium specimens housed in cardboard boxes into the sequence of classification housed in steel cases. It required 166 of the new steel cases to house properly the Arboretum specimens formerly kept in cardboard boxes. During the spring months the Arboretum staff undertook another long-neglected task, that of inserting the specimens which had been mounted in recent years. At the end of this fiscal year these housekeeping tasks are nearing completion. For the first time in over twenty years all of the Arboretum's organized collections are housed in steel herbarium cases. For the first time in nearly twenty years, all of the Arboretum's organized collections are in one systematic sequence.

There remains ahead for the staff of the Arnold Arboretum and that of the Gray Herbarium the task of placing in association the specimens of

each family, genus and species. While all specimens of a given family are now on the same floor and generally within a few cases or rows of cases from each other, it is hoped to organize these specimens gradually in proper proximity. This is a long task and it is planned to spend several years in completing the process. The major move of two large herbaria and libraries has been completed with only brief interruptions in the availability of the materials. During the move all the normal service and professional activities of the Arnold Arboretum continued without interruption. New programs were started, old programs were maintained. The majority of the staff worked devotedly at the task of maintaining and furthering the preeminent position of the Arnold Arboretum among the institutions of its kind in this country and in the world.

The Staff:

It is with regret that the staff loses through retirement during the past fiscal year two of its members, Professor Irving Widmer Bailey as Professor of Plant Anatomy and Miss Ethel Upham as Herbarium Assistant. Professor Bailey joined the staff of the Arnold Arboretum in 1933 and has been primarily responsible for the development of the wood, slide and pollen collections of this institution. He served as a member of the editorial board of the Journal of the Arnold Arboretum from 1941 to the present and was a frequent contributor to the pages of the Journal during that period.

Miss Ethel Upham joined the Arboretum staff as secretary in 1945 but her abilities as an editorial assistant and herbarium assistant enabled her to play a contributory role to the many facets of this institution.

In September, 1954, Dr. Carroll E. Wood, Jr., joined the staff of the Arboretum as Associate Curator. Dr. Wood received his Ph.D. from Harvard University and was Associate Professor of Botany at the University of North Carolina immediately before his appointment. With an interest in horticulture and in the flora of the southeastern United States and as a capable teacher and field botanist, Dr. Wood is a valuable addition to the staff. Among his many duties, he is in charge of the adult education program at the Arboretum.

Mr. Roger Coggeshall was appointed head propagator on July 1, 1954, following the resignation of Mr. Lipp.

Honors came to several of the staff members during the past year. Professor Bailey was awarded the Mary Soper Pope award by the Cranbrook Institute of Science at the meeting of the American Academy of Arts and Sciences at Berkeley, California. At the Commencement of Harvard University on June 16th, Professor Bailey was awarded an honorary Doctor of Science degree with the citation, "Today your university salutes you for your direction of botanical study and for your accomplishment in searching, in the anatomy of plants, for clues to the miracle of growth."

Dr. Donald Wyman was reëlected a trustee of the Massachusetts Horticultural Society at its annual meeting and Dr. Richard Howard was elected chairman of the nomenclature section of the Ninth International Botanical Congress. Dr. Kobuski was elected to the council of the New England

Botanical Club and also serves as assistant curator of the herbarium of the club.

Members of the staff officially represented the Arnold Arboretum at various scientific and horticultural meetings throughout the country during the year. Dr. Carroll Wood, Dr. Richard Howard and Dr. Hu attended the annual meeting of the American Institute of Biological Sciences at Gainesville, Florida, in September. Dr. Wood served as chairman at one of the meetings and Dr. Howard took part in symposia sponsored by the American Society of Plant Taxonomists on the "Origin of the Coastal Plain Flora" and by the Society for the Study of Evolution on "The Origin and Evolution of the Biota of Florida." Dr. Howard served as president *pro tem* at the annual banquet of the American Society of Plant Taxonomists. Dr. Hu spoke on her work on *Paulownia*.

Professor Bailey represented the Arnold Arboretum at the meetings of the Botanical Society of America and the American Association of Arts and Sciences.

Mr. Roger Coggeshall served as moderator of two symposia at the annual meeting of the Plant Propagators Society in Cleveland. Both Dr. Sax and Mr. Coggeshall presented papers at the New England Regional Meeting of the American Society of Horticultural Sciences held in Cambridge.

Dr. Sax was chairman of a section of the conference on mutations held at the Brookhaven Laboratory in New York and was a consultant at the radiation biology conference held by the Biology Department of the Oak Ridge National Laboratory.

The demand for members of the Arboretum staff as speakers to various meetings was high and it is impossible to list all the groups concerned. Dr. Howard was the principal speaker at the Wellesley College Garden Day program and spoke on "Hurricanes and Horticulture." Dr. Howard also presented one of the downtown lectures for the New York Botanical Garden, where he talked on "Horticultural Highlights of the Caribbean Islands." He talked about the work of the Arnold Arboretum to the Chestnut Hill Garden Club, the Kiwanis Clubs of Jamaica Plain and West Roxbury, the American Begonia Society and to the Tree Wardens of Middlesex County and on other topics to the Garden Clubs of Lowell and West Roxbury, Massachusetts, and the Garden Club of Short Hills, New Jersey, as well as the Womens Club of Worcester, Massachusetts, and of Western Massachusetts. Dr Wood talked on "Pollination of Plants" at a meeting of the Boston Horticultural Club and of the Gardeners and Florists Club of Boston. Dr. Wyman was one of the principal speakers at the Michigan Landscape Conference of Michigan State College, where he spoke on "New Plants for Contemporary Homes"; at the New York Botanical Garden's Rose Day, where his subject was, "The Wild Roses of the World" and the Rhode Island Shade Tree Conference when he talked on the subject, "Using Trees Wisely." Dr. Wyman spoke to garden clubs in areas ranging from Charlotte, North Carolina, to Durham, New Hampshire.

Mr. Williams spoke to the Milton Garden Club on pruning and Mr. Coggeshall was speaker at meetings of the Garden Clubs of West Roxbury,

New Bedford, Wareham, Marblehead and Cohasset on the subject of plant propagation. Mr. Coggeshall also spoke on the subject of "How an Arboretum Can Aid the Nurseryman" during the short course for nurserymen at the New York Agriculture School at Farmingdale, New York.

Horticulture:

Two devastating hurricanes ripped through the Arboretum in late August and September with Hurricane "Carol" on August 31st doing the more damage. Four hundred trees were either blown down or severely damaged. The ground force was able to pull back to an upright position and thus save approximately 25% of these within ten days of the storm. A brush chipper and two chain saws were bought with funds restricted to hurricane repair to aid in the process of cleaning up the debris. Small consolation for the loss could be found in the fact that the brush chipper supplied mulch for the remaining trees. By early spring most of the downed trees had been removed but the damage to branches will require many additional months of careful pruning and tree repair. Of all the trees blown down in these storms, only seven were not duplicated elsewhere in the collections. Attempts were made immediately to propagate these seven clones. All of the clean-up work was accomplished by the regular ground force, but the emergency made impossible the annual fall planting schedule.

The hurricanes were followed by a severe open winter. Nevertheless, the flowering display on the grounds during the spring months was one of the best in recent years. The dove tree bloomed profusely and with special publicity was sought out by many visitors. Equally outstanding in the quantity of bloom were the lilacs and the rhododendrons. The Dexter Rhododendrons fortunei hybrids on Hemlock Hill have never bloomed as well as they did this year.

Although lilac blight was fairly prevalent in surrounding areas this year, there was practically none in the Arboretum due to timely spraying with Puratized Apple Spray. The same can be said of fire blight on the crab apples which have received experimental treatments with "Agri-mycin" one of the newer antibiotics.

Lawn areas in the Arboretum received special applications of fertilizer this spring and the other collections were continued on the regular rotation program of application of fertilizer. Spraying for insect and disease control has taken a great deal of time, forty-seven man days in the past year, but the collections reflect the extra attention given them.

Two hundred and fifty species and varieties of plants were added to the major collections in Jamaica Plain during the year. Most of these represented plants new to the living collections of the Arnold Arboretum, although a few were planted to replace some of the older specimens. Plant materials collected by Dr. Wyman in Europe in 1952 and since held in post entry quarantine were released during the year and are now being propagated for the Arboretum collections and for distribution. Thirty new varieties of rhododendron were either purchased or given to the Arboretum

and will eventually be added to our rapidly growing rhododendron collection.

Nine new or very rare plants were propagated and distributed to thirty-two nurserymen and botanic gardens in the United States, Canada, England and Holland as a continuation of our important plant introduction and distribution program. This year the plants distributed included *Cytisus praecox luteus*, a dwarf form of the species not otherwise available in America; *Larix decidua pendula*, a plant which we feel should be grown more than it is; a male form of *Phellodendron amurense* which is unavailable currently from commercial sources and a new dark red-flowered bush honeysuckle which originated in the Arnold Arboretum in 1947. In addition, the Arboretum continued its efforts in cooperating with other arboreta in the United States and the Department of Plant Introduction of the U.S. Department of Agriculture to make it possible to obtain from foreign sources certain woody plants which formerly have been forbidden entry. The Arboretum obtained twenty-three species and varieties under this program this year. None of these is currently under cultivation in the United States.

During the past year one hundred and twenty-seven shipments of plant materials of four hundred and seventy-three species and varieties were sent from the Arnold Arboretum to other institutions in nine countries. In addition to the United States, such materials were sent to Canada, England, Japan, Sweden, Israel, Iceland, Holland and Switzerland. In exchange or by special request, subsidy of foreign collectors or by purchase, the Arnold Arboretum received one hundred and forty-nine shipments comprising five hundred and seventy-five species and varieties. These materials came from ten countries on three continents other than North America. Many of the plant materials received must be regarded as experimental in nature for trial under the local growing conditions. While all plants are regarded as excellent ornamental trees or shrubs in the area in which they were collected, not all will grow at the Arboretum. An excellent example is the outstanding Glen Dale Azaleas which have been tried on several occasions at the Arboretum or at the Case Estates. Several years ago an attempt to grow the Glen Dale Azaleas without winter protection resulted in the loss of the entire planting. Last year a similar experimental plot was established and the plants were given normally adequate winter protection. In spite of this, most of the plants were killed or severely injured in what was a "severe" winter for broad-leafed evergreens.

The physical plant for horticulture, both the Administration Building and the greenhouses received special attention during the past year. In addition to the alterations in the rooms of the Administration Building open to the public, the horticultural herbarium was repainted and its appearance generally improved. The basement was cleaned up and locker and lunch rooms established. New safety doors to the buildings were built. At the greenhouse area the greenhouses themselves received new glazing where necessary and the frame work was painted. The class room for the plant propagation classes was established and a major overhaul was accomplished

on the cold pits. Some of the shade and lath frames were destroyed during the hurricanes and these were rebuilt. An automatic ventilating machine was installed in the east greenhouse during the summer of 1954 and the greenhouse benches were made watertight by lining them with asphalt roofing paper. These benches were then filled with sand and chicken fountains modified for automatic watering were set up at the higher ends of the benches. The chicken fountains allowed the water to seep into the sand and the potted plants on the benches were watered from below by an economical and simple system which is semi-automatic in operation. As the cutting benches holding plants to be rooted are under polyethylene plastic film, the greenhouse can now safely operate without care for periods up to three days.

Dr. Wyman taught three classes in the adult education program during the past year and all were well attended. In addition to editing Arnoldia and seeing the Arnold Arboretum Garden Book through the final steps of publication, Dr. Wyman found time to supervise the work of the horticultural department and to lecture to many garden clubs. He was asked by the American Association of Botanic Gardens and Arboretums to revise his "Crab Apples for America" which is now being set in type for fall publication by the Association.

Mr. Coggeshall proved himself an inspiring teacher when enrollment required that he offer three sections of his course in plant propagation in the fall and again in the spring. His routine work as propagator resulted in the production of 21,942 new plants for Arboretum activities. Of these, 19,829 were reproduced by cuttings; 1,801 by grafting; 330 by budding and 279 lots of seeds were germinated and processed. With the cooperation of other members of the horticultural staff, various experiments under Mr. Coggeshall's direction were initiated or maintained in the greenhouses. The effects of different hormone treatment and of rooting media are being studied on *Magnolia*, *Stewartia*, *Syringa*, *Azalea* and *Acer*. Various species of *Vaccinium* are receiving controlled treatments for a study of rooting response to different hormone concentrations. An additional study is being made on these vacciniums to determine the advisability of storing the cuttings before rooting is attempted. *Ilex opaca* is also being studied for the effects of rooting response to different hormone concentrations and both before and after over-wintering the cuttings in refrigerated space. Replicate experiments are being run on *Hamamelis*, *Acer*, *Fagus*, *Tilia*, *Aesculus* and *Betula* species to determine the simplest type of grafting procedure possible with these species and to compare the results of graft unions made with polyethylene or waxed string ties. The effects of concentrated sulfuric acid treatment of seeds of species of *Rosa* and *Ilex* as a means of hastening germination is under study, as is the effect of polyethylene plastic on bud take of *Prunus serrula*.

Mr. Heman Howard continued to take colored as well as black and white pictures of the plants of the Arboretum collections and these were added to the reference files in the horticultural library. Mr. Howard was also in charge of the usual winter activity of preparing the wooden display

labels and the metal record tags which are placed on all plants in or added to the living collections. He assisted in the routine activity of checking a third of the Arboretum each year in relation to our maps, which are then redrawn if necessary to bring them up to date.

The entire Arboretum staff takes part in the activities of the Arboretum relating to groups of visitors and the answering of many questions. Horticultural queries came from 27 states and 14 foreign countries during the year, with telephone calls too numerous to count. Identifications of plants sent in for naming are handled by both the horticultural and herbarium staffs. Many queries are received relating to sources of plants normally difficult to obtain. The library collection of nursery catalogues are used to answer such questions, in addition to other more standard source books. Services such as these are time-consuming, but an integral and valuable part of the many services the Arboretum staff can and does offer to the public, to nurserymen and to other professional colleagues.

### The Case Estates:

Considerable damage was done to the trees about the Case Estates by the two hurricanes, but such damage was in no way comparable to that felt in Jamaica Plain. The staff was able to clean up and remove the debris, although a commercial arborist was hired to assist in the repair of the trees by proper pruning of broken branches.

A major reorganization was made in the arrangement of the temporary and permanent nurseries to facilitate a land improvement program and to make new plantings easier. Since Weston's New Country School just opened on the land adjacent to the lower field, it has received special publicity and many visitors. To improve the vistas from this school area, the overgrown shrubs and some of the trees in the lower field were removed. This new open area materially increases the beauty of this important and much-travelled portion of the town of Weston. Permission was given to the town of Weston to relocate a portion of the stone wall around the ground cover plots to remove a traffic hazard and improve an access road from town property.

Experimental work continues at the Case Estates. Rhododendrons were sprayed in the fall with either "Dow-wax" or "Wilt-Pruf" and were in excellent condition the following spring, showing neither bad effects from the treatment nor from winter injury. The application of "Wilt-Pruf" appeared to result in a better appearing plant by spring, although it gave no indication of better protection.

Maleic hydrazide was tried as a control of growth of grass and of a *Prinsepia* hedge but without noticeable results. Careful observation has also been made of our practice of using polyethylene plastic film as a wrapping material in packing plants for shipment. Experiments during the past year showed that dormant, bare-root azalea plants kept tightly wrapped in this material for three weeks grew normally when planted. These experiments showed that plant materials sent from the Arnold Arboretum may be expected to grow if handled properly by the recipient.

Land was made available on the Case Estates for continuation of the work of the Cabot Foundation for the growth of poplar, pine and oak and of the Bussey Institution for growing dwarf apple trees and corn.

Over thirty clones of *Rhododendron fortunei* hybrid selections are growing well in the Ericaceous nursery. These have been picked from some of the best plantings in the area from Long Island to Newburyport.

Winter injury again disfigured most of the Deutzias, Spiraeas and many of the Weigelas in the permanent nursery, proving once again the wisdom of growing less desirable record plants at the Case Estates instead of in the major collections in Jamaica Plain. During the spring the *Weigela*, *Philadelphus* and *Deutzia* collection of certified varieties from de Proeftuin te Boskoop, Holland, obtained in 1951, bloomed well and will shortly be valuable for purposes of identification of these groups.

The "Open House" held at the Case Estates on May 7 and 8 was well attended in spite of inclement weather. The interest in the shrub and perennial garden made clear the desirability of placing display labels on all the plants in this garden. Formerly only location maps were maintained for this planting. Interest in the ground cover plots and the small tree demonstration area remained high following the Open House.

**The Adult Education Program:**

In the fall of 1954 the staff of the Arboretum introduced on a regular schedule an adult education program. The classes, offered for a nominal fee to cover the expenses of the courses, were designed to present to the public interested in horticulture and scientific botany an opportunity to become familiar with topics of interest, as well as with the staff members themselves and the resources of the Arnold Arboretum. Classes were held in the new lecture room at the Administration Building in Jamaica Plain or at the Greenhouses. All of the classes were informal, with no prerequisites and no academic credit given. Each member who attended regularly, however, received a certificate at the completion of the course or a small plant as a "graduation" gift. Many of the classes featured practical laboratory work with plant materials and nearly all called upon the use of kodachromes from the Arboretum's collections to illustrate the materials and methods of the topic. The four courses offered in the fall were Basic Botany for the Home Gardener by Dr. Wood; Fall Field Class in Ornamental Plants by Dr. Wyman; Plant Propagation by Mr. Coggeshall and Tropical Botany by Dr. Howard. One hundred and thirteen students enrolled for these courses.

During the spring semester additional courses were offered to one hundred and fifty-two students. These were Maintenance of the Home Grounds by Mr. Williams; Spring Field Class in Ornamental Plants and The Best Woody Plants for New England, both by Dr. Wyman and Plant Propagation by Mr. Coggeshall.

The staff plans to continue offering adult education classes on these and other subjects in succeeding years. Interest in this informal instruction in horticulture and more basic aspects of botany is growing.

In addition to these courses, the Arboretum staff offered many shorter sessions and conducted tours of the grounds or the facilities of the Arboretum. During the peak of the spring flowering season the staff explained the work of the Arboretum and offered tours of the grounds to thirty-five groups. Groups varied in size from the minimum of twenty-five persons required for a guided tour to the over four hundred persons who attended the annual Field Day of the Massachusetts Horticultural Society at the Arnold Arboretum. Special demonstrations of pruning, plant propagation or other techniques for maintaining trees and shrubs were conducted for the Field Day of the Massachusetts Horticultural Society and for the meeting of the Horticultural Chairmen of the Federated Garden Clubs of Massachusetts.

**Exhibits and Displays:**

The newly available demonstration room in the Administration Building of the Arnold Arboretum offered to the staff the opportunity of presenting exhibits and displays of plant materials. The first exhibit held during the past year was a display of original paintings of tropical flowering trees and shrubs. The collection of twenty-nine paintings *in tempera* depicted the most spectacular flowering plants of the Caribbean area. The paintings by Bernard and Harriet Pertchik were all included in the book, "Flowering Trees of the Caribbean," published by Rinehart and Company in 1951. The paintings were sponsored by the Alcoa Steamship Company and their loan to the Arnold Arboretum was appreciated by the staff as well as the many residents of New England who saw this exhibit.

During the Christmas season the featured exhibit at the Arboretum was a collection of evergreens for Christmas. The most common evergreen trees and shrubs and those used as Christmas trees or in Christmas greens were on display with appropriate botanical information supplied on labels. Additional displays at the time centered attention on plant materials for wreaths and on the methods of improving the keeping quality of Christmas greens. A large Douglas fir, a victim of the September hurricanes, served as a Christmas tree for the occasion and was decorated with painted fruits and seeds from native plants. The excellent newspaper coverage given this display drew many visitors to the Arboretum during the Christmas holidays.

A collection of outstanding large-sized photographs by Dr. Wyman and Mr. Heman Howard of the best trees and shrubs, formed a display for the early spring months and was replaced in April by an exhibit of pruning methods and materials prepared by the horticultural staff. Many of the trees damaged or destroyed by the hurricanes which swept through the Arboretum the previous fall showed evidences of both good and bad pruning at an earlier date. These plant materials were used to advantage in the pruning exhibit. The example of a tree destroyed because a forgotten guy wire was left in place made a forceful reminder to those visitors who had supported trees in such a manner following Hurricane Carol. Examples of trees which died because of girdling roots or an earlier potbound condi-

tion, as well as trees which suffered rot for lack of protective paint following pruning were used to illustrate proper and improper tree care.

The exhibit of the Arnold Arboretum at the Spring Flower Show of the Massachusetts Horticultural Society featured ground cover plants in a setting designed to show the type of plant to be used for a variety of exposures. The exhibit had a favorable location in the hall and attracted much attention and comment. Again this year the Arboretum was awarded a gold medal for its exhibit.

Mrs. Schwarten prepared special library exhibits for meetings of the Bio-Historical Club and the Harvard University Library Club. Both organizations met in the Harvard University Herbarium and were particularly interested in the library, its management and its resources.

During the annual meeting of the Federated Garden Clubs of Massachusetts held at the New Ocean House in Swampscott, Massachusetts, the Arboretum exhibited a collection of flowering trees and shrubs as well as ektachrome display panels. As two other conventions were in progress in the hotel during the course of this exhibition, the plants received unexpected attention.

The Arboretum was fortunate during the year in having excellent cooperation from the newspapers, radio and the television stations in publicizing all of its activities, as well as the flowering season at the Arnold Arboretum. Without this cooperation our attendance would not have reached the gratifying stage it did. Over 300 newspaper or magazine clippings (or notices) about the Arnold Arboretum have accumulated during the year. Channel 2, Station WGBH-TV, through its "Images" program, featured the plants of the Arboretum by using kodachrome slides from the Arboretum collection. While we all wished colored projection were possible to bring out the full beauty of both the slides and the plants, the inquiries following these programs indicated a receptive audience.

The Arnold Arboretum staff served as hosts to visitors at two well publicized "Open Houses." On December 17 and 18 an "Open House" was held at the Administration Building in Jamaica Plain and in spite of inclement weather a sizable group attended to inspect the alterations in the building and to see the exhibits. On May 7 and 8 an "Open House" was held at the Case Estates in Weston. Parking became a problem on both of these days on the narrow Weston road, for the location of the Case Estates is away from public transportation. Our best estimates are that 3000 people visited the Case Estates during those two days and were particularly interested in the perennial garden, the woods garden, the ground cover plots and the various nursery collections of new introductions. It is our hope that annual open houses can be conducted at both Jamaica Plain and at the Case Estates in future years.

Library:

The actual move of the larger part of the Arboretum library to the new quarters in the Harvard University Herbarium in Cambridge was completed in the first month of the past fiscal year. During the remain-

FIG. 3. Top. A portion of the reading and reference room in the Harvard University Herbarium.

FIG. 3. Bottom. The center aisle of the library stack area in the Harvard University Herbarium in Cambridge. The Arboretum books are on steel shelving in an air-conditioned building where humidity is controlled and dust is filtered from the air.

ing portion of the past year Mrs. Schwarten, the librarian, capably assisted by other staff members, has devoted her time to rearrangement, labelling, cataloguing and reconditioning the books in both the horticultural library in Jamaica Plain and the non-horticultural library in Cambridge. It is with gratitude that acknowledgment is made of the efficient and devoted care being given the books of the Arnold Arboretum. Throughout the move, routine library activities were unhampered and requests for inter-library loans, assistance to staff members attempting research and consideration of interested visitors were accomplished.

At the completion of the new library quarters in the Administration Building in Jamaica Plain, the books and reference volumes were arranged on steel shelves in the reading room on the first floor. A special table is devoted to the display of current periodicals as they are received and back numbers of current volumes are on special shelves and readily available. On the second floor of the Administration Building, steel shelves were erected to accommodate the bound volumes of periodicals dealing with horticulture and horticultural subjects. A complete card catalogue of all horticultural holdings, including a periodical catalogue, is maintained.

The major task of arranging on steel shelves the books moved to Cambridge was accomplished through efficient and flawless planning. These books are receiving continuing attention for correct placement, cataloguing and labelling. All volumes are being cleaned and bindings are being treated as required. A master card catalogue is maintained to indicate horticultural holdings in Jamaica Plain as well as those volumes in the non-horticultural library. During the past year 536 volumes were added to the libraries either by gift, purchase, exchange or binding, bringing the accessioned total number to 49,209. Pamphlets received and added to the library collections numbered 340, bringing the total to 15,750. One thousand nine hundred and seventy-five catalogue cards were added to the master catalogue and 4066 cards to the Gray Herbarium species card index.

The library of the Arnold Arboretum received many useful gifts of books, pamphlets and photographs during the past year. It is a pleasure to acknowledge the gift mentioned elsewhere from Mr. and Mrs. F. H. Palmer, as well as particularly fine gifts from Mr. Arthur Shurcliff and Mrs. Roy Arthur Hunt. Mr. Shurcliff presented a copy of Miller's Gardener's Dictionary and Mrs. Hunt a gift which included two manuals of Gardening from English manuscripts in her own collection. The library of the Arnold Arboretum also received from the Baker Library of the Graduate School of Business Administration a collection of thirty botanical volumes from the Winthrop collection in particularly fine bindings.

Frans Verdoorn, Research Associate, spent much time, during the past year, on the preparation of a revised edition of his *World List of Plant Science Institutions*. The new, fifth edition will include more than twice as many entries as the fourth edition of 1938.

Work on the biographical card index of plant scientists, being prepared as a basis for the *Index Botanicorum*, continued as in previous years, with

the aid of three assistants. The index consists now of about a million cards.

Work towards an annotated bibliography on *Linnaeus and his Time* was continued in an effort to display Linnaeus' life and manifold activities in their full historical context.

## Herbarium:

The facilities of the Harvard University Herbarium and the additional space now available in the Administration Building in Jamaica Plain have afforded the herbarium staff the desired opportunity for expansion and proper organization of the herbarium collections of the Arnold Arboretum. The herbarium in the Administration Building in Jamaica Plain is devoted to specimens of plants under cultivation anywhere in the world, with particular emphasis on those cultivated at Jamaica Plain. These cultivated specimens are supplemented with specimens of spontaneous taxa to allow proper study and determination of the cultigens. The horticultural herbarium was expanded during the past fiscal year to loosen the specimens in each case. The entire herbarium was checked for coverage in relation to such manuals as those by Rehder and Bailey. Specimens needing repairs are being afforded the treatment required in a systematic fashion. The horticultural herbarium has been indexed not only by family but by genus as well, for the convenience of visiting horticulturists. It is of interest to note that during the past year visitors were often interested in either herbarium, but rarely did their work involve both.

The specimens moved to Cambridge were transported in the steel cases or cardboard boxes used to house those specimens in Jamaica Plain. During the year Miss Perry, with the assistance of two student workers, completed the major task of inserting into the steel cases in their proper sequence all specimens formerly contained in cardboard boxes in Jamaica Plain. When this task was completed the long-delayed distribution of recently mounted specimens was begun. Currently the work is also under way to place in proximity the specimens representing families of flowering plants in the herbaria of the Arnold Arboretum and the Gray Herbarium.

During the past year 6,655 specimens were mounted and added to the two herbaria, bringing the total accession count to 681,747 specimens in the herbaria of the Arnold Arboretum. Additional collections and specimens were received, totalling 13,716 numbers. Of these 10,133 were received in exchange and 3,211 by purchase or subsidy of expeditions or collectors. The remainder were received as gifts or in exchange for identifications. Ninety-four percent of the specimens received represented plants from Malaysia, Asia, Africa, Europe and Australia in that order. In recent years the Arnold Arboretum has contributed to the financing of expeditions to New Caledonia, Northern Burma and Kenya Colony. The botanical results of these expeditions are now being made available and the specimens received in terms of subsidy were from these important areas.

FIG. 4. Top. A portion of the herbarium area in the Harvard University Herbarium. All of the specimens of the Arnold Arboretum are now housed in steel herbarium cases.

FIG. 4. Bottom. A portion of one of the offices for the staff of the Arnold Arboretum in the Harvard University Herbarium. The wall sorting cases for herbarium specimens were specially designed for this building. Recessed lighting throughout the building supplies excellent, evenly-distributed illumination.

Requests for loans of herbarium specimens in the collections of the Arnold Arboretum remained high and in spite of the move in progress, all were handled promptly. Requests were honored for 86 loans to 51 institutions and the loans averaged 130 specimens. The staff feels that the time spent in locating, removing and packing these specimens for shipment to fellow scientists is not only repaid in kind but also enables us to maintain an active herbarium, with specimens determined by specialists. Nevertheless, it is acknowledged that preparing the loans and replacing the sheets in their proper position when the loan is returned is expensive in terms of staff time. The largest number of requests for material on loan came from botanists in the United States, with other requests coming from Europe, Canada, South America, Asia and New Zealand, in order of frequency.

During the year staff members conducted research on plant families and areas of their specialty. Dr. Howard continued his work on the vegetation of bauxite soils in cooperation with the botanists of the Institute of Jamaica, British West Indies. He also was able to devote some time to his studies of petiole structure, the horticultural plants of Florida and the American tropics and to general Caribbean collections.

Dr. Wood made two field trips to the southeastern states and worked on the determination of these plants. He continued his studies of the genus *Hedyosmum* and completed work on *Drosera*.

Dr. Kobuski devoted almost full time to his duties as curator of the herbaria in supervising the work in progress. In addition to his work as editor of the Journal of the Arnold Arboretum, Dr. Kobuski prepared a new edition of a glossary of horticultural terms and continued his studies of the Asiatic members of the Theaceae.

Dr. Johnston taught his course, "Phylogeny and Classification of the Flowering Plants" and devoted the remainder of his time to his research on the Boraginaceae. He gave special attention to the morphology and classification of *Echiochilon* and related genera from the deserts of Africa, Arabia and southern Asia. His studies of the poorly understood genus *Microula* of Tibet and western China are well advanced. He has prepared three long papers on the Boraginaceae for publication.

Dr. Perry devotedly gave her full time to arduous work in the organization of the herbarium. It was largely through her efforts that the specimens housed in cardboard boxes were efficiently transferred to their proper positions in the regular herbarium. In the latter part of the year Miss Perry was able to turn a small part of her attention to her own research interests on the vegetation of New Guinea and she was able to resume her work on the extensive collections of L. J. Brass from Papua.

Dr. Hu, botanist of the Flora of China Project, efficiently supervised the work of Dr. Liu and Dr. Ting. Together they have continued the indexing of Chinese plants and the preparation of a card file to record the Chinese vegetation. Dr. Hu and Dr. Liu together have completed a treatment of the family Malvaceae as it occurs in China.

## Comparative Morphology:

During the past year the wood, wood slide and pollen slide collections of the Arnold Arboretum formerly housed in the Biological Laboratories were transferred to the Harvard University Herbarium. These collections occupy a large room on the first floor adjacent to the paleobotanical collections and convenient to the herbarium. Professor Bailey and his assistants completed the necessary rearrangement of materials in the new cases housing these collections. The wood collection is now in the same systematic sequence as the herbarium.

The most valuable additions to the collection in the past year are the specimens secured in Fiji by Dr. A. C. Smith and the specimens of the genus *Coccoloba* collected by Dr. R. A. Howard in the Caribbean Islands. During the year valuable specimens of the woody Compositae were contributed by Mr. Carlquist of the University of California; numerous slides of the Magnoliaceae by Professor Canright of Indiana University and valuable slides of *Garrya* by Professor Moseley of Santa Barbara College.

The wood collection, and particularly the microscope slide collection related thereto, have become increasingly significant in the study of plant relationships and classification and in the identification of fossil woods. In addition, they have rendered a public service in solving problems raised by art museums, archeologists, criminal divisions of the police department, timber users and others.

## Cytogenetics:

Dr. Karl Sax, his assistants and students reported the following contributions in the field of cytogenetics. New hybrids of *Forsythia*, *Rhododendron*, *Philadelphus*, *Prunus* and *Malus* developed at the Arnold Arboretum were grown in the nursery in Jamaica Plain and in test plots at the Case Estates in Weston. Four of the best of the apple hybrids which merit distribution have been named in honor of associates of the Arnold Arboretum. These were published in Arnoldia and are *Malus* × "Henrietta Crosby," *Malus* × "Blanche Ames," *Malus* × "Henry F. duPont," and *Malus* × "Mary Potter."

An analysis of the relations between aneuploidy and morphological characters among the progeny of triploid *Forsythia* and *Philadelphus* was made by Dexter Sampson.

The various techniques used for producing dwarf fruit trees which have been tested at the Arnold Arboretum in Jamaica Plain and in Weston have now been used to produce dwarf ornamental trees. The use of dwarfing rootstock has given promising results with several species of maple which would be equally desirable as dwarf trees.

Two chemical preparations for use with plant materials have been developed which are proving of interest and value to horticulturists. A compound of 10% weed killer (equal parts of 2,4,5-T and 2,4-D) in a paste of lanolin or similar grease can be used to kill poison ivy growing in among

vines or shrubs without injury to the adjacent plants. A second compound of 10% wettable chlordane in a lanolin or grease base when painted on the trunks of peaches and similar trees effectively controls boring insects. Both compounds will soon be available from commercial sources.

The work on the effects of ionizing radiation, supported by the Atomic Energy Commission, has led to the use of X-rays to promote earlier flowering in certain plant species. Ornamental trees and shrubs from the Arnold Arboretum are being grown in the "gamma field" at Brookhaven, Long Island, for the induction of bud mutations in collaboration with the Brookhaven National Laboratory.

**Instruction:**

During the year various staff members continued their cooperation with the Department of Biology of the University in presenting formal courses, informal seminars and guiding the work of graduate students. Dr. Ivan Johnston offered an advanced course in plant taxonomy in the spring semester. Dr. Karl Sax continued his guidance of the work of Mr. Dexter Sampson and Julian Jaffee. Mr. Jaffee completed his thesis and received his degree at midyear's. Dr. Richard Howard supervised the graduate work of Miss Siri von Reis on the botanical activities and travels of Erik Ekman and of Mr. Tchang Bok Lee, an UNKRA fellow from Korea who is working on the forests and forest products of Korea. Cooperation was also offered to the School of Landscape Design of Harvard by Dr. Howard, under whose direction several classes studied the plant materials on the grounds of the Arboretum.

Many of the staff members attended and took part in the seminars offered in the field of plant systematics for graduate students and staff at the Harvard University Herbarium. An average of thirty persons attended these weekly seminars, which were conducted throughout the year. Dr. Wood spoke on "Hybridization in Drosera"; Dr. Perry on "Plant Exploration in New Guinea"; Dr. Kobuski on "Problems in the Theaceae" and Dr. Howard on "The Use of Anatomical Characters of the Petiole as an Aid to Plant Classification."

**Travel and Exploration:**

New horticultural introductions as well as herbarium specimens came to the Arboretum through the field efforts of its staff as well as through expeditions by foreign collectors supported by the Arnold Arboretum. Of the staff members, Dr. Howard and Dr. Wood carried on botanical explorations during one trip to southern Florida and the Bimini Island group of the Bahamas in the British West Indies in February. On this trip they collected in the Florida Everglades National Park and visited the Fairchild Tropical Garden, the Kampong (the home of Mrs. David Fairchild), the Coconut Grove Plant Introduction Station of the U.S. Department of Agriculture and the Gifford Arboretum of the University of Miami. In the Bahamas they were guests of the American Museum of Natural History at the Lerner Marine Laboratories where they continued

FIG. 5. Top. Mr. Roger Coggeshall instructing one of the adult education classes in plant propagation held at the greenhouses in Jamaica Plain.

FIG. 5. Bottom. Dr. Donald Wyman (at right, back to camera) discusses the lilac collection of the Arnold Arboretum with members of the Spring Field Class of the Adult Education Program.

explorations of those islands begun by Dr. Howard in 1948. In addition to field studies, work was done on the cytology of tropical plants and in anatomical investigations of tropical plant species. Dr. Howard also continued the cooperation between the Arnold Arboretum and the Institute of Jamaica in Kingston, Jamaica, British West Indies. He spent three weeks in September working with the botanists of the Institute in conducting a survey of the vegetation on bauxite soils which are to be mined by several aluminum companies.

In April Dr. Wood traveled and collected in North Carolina, South Carolina and Georgia. He brought back to the Arboretum over fifty living collections, species and hybrids of *Robinia*, the rose acacia, for addition to our living collections or for testing and study in connection with his investigations of that genus. Dr. Wood was also able to obtain living material of *Liquidambar styraciflua var. rotundiloba*, named by Dr. Rehder but not currently in the Arboretum's collections.

During the year the Arboretum supported expeditions in Australia, Japan and South America and from these expeditions obtained seeds of ornamental plants for trial in the United States.

## Gifts and Grants:

The Arnold Arboretum is fortunate to have the new and renewed financial support of a large group of benefactors known as the Friends of the Arnold Arboretum. The support of our work by these loyal benefactors among whom are many organizations is deeply appreciated by the entire staff. Gifts from the Friends to Harvard University for the purposes of the Arnold Arboretum, unless specified for particular purposes, are assigned to a fund known as Gifts for Cultural Purposes. During the past fiscal year such funds were used to employ additional seasonal labor in the maintenance of the grounds, to carry on experiments in the winter protection of evergreens, particularly rhododendrons, and to afford research assistance to members of the staff for work on horticultural projects.

In addition to these gifts for unrestricted purposes, the Arboretum has received gifts and grants for special research projects and special purposes. The largest of these from the China International Foundation supports the work of three botanists and two secretaries in investigations of the flora of China. Grants from the Stark Brothers Nurseries for the work of Dr. Karl Sax has supported investigations in methods of dwarfing trees by the control of growth. Dr. Sax has also received grants from the atomic energy commission for study in the effects of radiation on cell division and growth and in the transport of materials through the body of plants.

Dr. Carroll Wood received a grant from the American Association for the Advancement of Science through the American Academy of Arts and Sciences for exploration and collection of materials in the Gaspe Peninsula of Canada. This work will be completed during the coming summer months.

A gift for the specific purpose of "repair of hurricane damage" was received from the Association for the Arnold Arboretum, Inc. With the approval of its president and board of directors, this gift was used to pur-

chase a brush chipper and chain saw to facilitate the removal of fallen trees.

A non-departmental gift from Mr. George R. Cooley for taxonomic work at the joint discretion of Dr. Reed Rollins, Director of the Gray Herbarium, and Dr. Richard Howard has been utilized to support field work and research on the vegetation of the southeastern states and the adjacent Caribbean Islands. Travel leading to collections and determinations of the woody ornamental plants under cultivation as well as the native and spontaneous plants of the area has been made possible through this gift.

Gifts in kind, including books for the library as well as herbarium specimens, have been received from many sources. Mr. Harvey Templeton, Jr., kindly presented to the Arnold Arboretum an experimental intermittent mist propagation system which has been erected near the greenhouses. This gift will enable Mr. Coggeshall and others to run comparison tests of rooting techniques on woody plants under the polyethylene plastic and under the intermittent spray system.

The Arboretum is particularly indebted to Mr. and Mrs. F. H. Palmer of Wellesley, Massachusetts, for a gift of 150 bound volumes of books and periodicals from their library, many of these originally in the library of Mr. H. H. Hunnewell. This important gift of volumes in fine bindings not only adds several valuable items to the libraries but gives us a number of reserve copies for volumes in continuous use and receiving wear.

From the trustees of Lingnan University the Arboretum has received a gift of 8058 herbarium specimens representing plants of China. These specimens were borrowed by staff members of the Arboretum prior to the war years and were packed ready to be returned at the outbreak of World War II. As the specimens were being kept apart as a loan to be returned, they could not be studied or cited and were difficult to afford proper care. The trustees of Lingnan University, recognizing the value of these specimens, if accessible, to the work of the Arboretum and other institutions, presented them to be incorporated in the herbarium. The specimens were all stamped with a special imprint recognizing the date of this gift. When it is possible to reëstablish botanical work in China at the Lingnan University, the Arboretum will replace this gift with comparable specimens from its collection of duplicates of plants from China.

**Publications:**

The breadth of interest and the nature of the activities and the contribution of the staff of the Arboretum is always indicated in the bibliography and published writings given at the end of the annual report. I wish, however, to call special attention to the publications of the past year.

The request for out-of-print numbers of articles which appeared in the Bulletin of Popular Information and in Arnoldia led to the reprinting of many of these articles as *The Arnold Arboretum Garden Book*. This book of 354 pages, published by D. Van Nostrand Company, Inc., was edited by Dr. Wyman. It has been widely and favorably reviewed and meets the needs of the public interested in woody trees and shrubs for information on

selection and care of such plants. Dr. Wyman also completed the manuscript and the proofs for a new edition of *Crab Apples for America,* to be published by the American Association of Botanic Gardens and Arboretums.

Two other books by staff members were published during the course of the last fiscal year and two others were seen through proofs and will appear shortly.

*The Botany of Cook's Voyages*, by Dr. E. D. Merrill, was published by Chronica Botanica and appeared in December, 1954. This book is in one regard a summary of many of Dr. Merrill's investigations in the origin and distribution of the plant life of the Pacific Islands.

The Chronica Botanica Company also published a selection of the research papers of Professor I. W. Bailey in December, 1954, under the title of "Contributions to Plant Anatomy." The staff takes pride in the fact that almost all of the papers reprinted in this book appeared in the Journal of the Arnold Arboretum during the course of Professor Bailey's active career.

Dr. Sax completed work on his study of population problems among the world's people and this book entitled, *Standing Room Only* is to be released in July by the Beacon Press.

Mrs. McKelvey is also completing the index to her book, *Botanical Exploration of the Trans-Mississippi West, 1790–1840*, which will be published in the fall.

New brochures describing the activities, resources and personnel of the Arboretum were prepared and have been distributed to garden clubs and in connection with the various open houses held.

Twelve issues of Arnoldia were prepared under the editorship of Dr. Wyman. An issue was distributed on September 24th reporting on the hurricane damage and was followed on October 15th by a special number devoted to the "Rehabilitation of Trees Injured by Hurricanes of 1954." In response to many requests for an earlier issue of Arnoldia, now out of print, Mr. Coggeshall brought up to date the information on the uses of polyethylene plastic at the Arboretum. Appropriately, at Christmas time Dr. Wyman published a delightful biographical sketch of Wilfrid Wheeler, "the Holly man" and listed with descriptions the best of the fruiting hollies named by Mr. Wheeler. Dr. Karl Sax described the work of the Arboretum staff in the field of plant breeding in the April issue of Arnoldia, while other issues appropriate to the season covered the subjects of forcing woody plants for early bloom, lilacs and old fashioned roses.

Four quarterly issues of the Journal of the Arnold Arboretum were published under the editorship of Dr. C. E. Kobuski. The articles in the Journal are more technical in nature. Priority of publication goes to staff members of the Arboretum and, in general, articles by other authors are accepted if they are based on materials in the collections of the Arboretum. Many of the articles dealt with basic investigations in horticultural subjects such as "The Control of Tree Growth by Phloem Blocks" by Dr. Sax, "Polyploidy and Apomixis in Cotoneaster" by Mrs. Sax, "Induction of Early Flowering of Ornamental Apple Trees" by Karl Sax and Albert

Johnston and "A Monograph of the Genus Philadelphus" by Dr. Hu. Other articles, such as "The Cyperaceae Collected in New Guinea by L. J. Brass, IV" and "The Cryptogams of the 1948 Archbold Cape York (Queensland) Expedition," were submitted by specialists who worked on collections made by an Arboretum-sponsored expedition.

The April and July numbers of Volume 36 of the Journal of the Arnold Arboretum were combined in a special issue dedicated to Professor Bailey by the editorial board. All of the papers were prepared at our request by former students and associates of Professor Bailey. The combined number carried the following dedication:

"On the occasion of the retirement of Professor Irving Widmer Bailey, after twenty-two years on the staff of the Arnold Arboretum and forty-seven years of service to Harvard University, we, his associates on the editorial board of the Journal of the Arnold Arboretum, dedicate this issue to him.

"The authors of the articles in this special number of the Journal represent only a few of the students and associates of Professor Bailey who would pay tribute to him at this time. We honor him with this issue in recognition of his contributions, his high standards of research, his integrity in science and personal life, and his guidance of and inspiration to students in the field of botany."

### Bibliography of the Published Writings of the Staff and Students
### July 1, 1954 — June 30, 1955


BAILEY, I. W. (with Margery P. F. Marsden). A fourth type of nodal anatomy in Dicotyledons, illustrated by Clerodendron trichotomum Thunb. Jour. Arnold Arb. **36:** 1–50. *pl. 1.* 1955.

BAILEY, I. W., *editor.* Contributions to plant anatomy. Chron. Bot. **15:** *i–xxvi,* 1–262, *pl. 1–23.* 1954.

COGGESHALL, ROGER G. Polyethylene plastic — its application to the propagation of hardwood cuttings. Arnoldia **14:** 57–63. 1954.

——— Using plastic in Rhododendron propagation. Am. Nurseryman **100** [10]: 8, 9. 1954.

HOWARD, RICHARD A. The Arnold Arboretum and the decision of the Massachusetts Supreme Court. Newsletter Amer. Assoc. Bot. Gardens & Arboretums **22:** 1–6. 1955.

——— The Director's report on the Arnold Arboretum during the fiscal year ended June 30, 1954. Jour. Arnold Arb. **35:** 367–381. 1954.

——— Harvard and the Arnold Arboretum. Bull. Garden Club of America **42:** 13–15. 1954.

——— The Harvard University Herbarium. Flora Malesiana Bull. **11:** 425–427. 1955.

——— The Vegetation of Beata and Alta Vela Islands, Hispaniola. Jour. Arnold Arb. **36:** 209–239. *pl. 1–5.* 1955.

HU, SHIU-YING. A monograph of the genus Philadelphus. Jour. Arnold Arb. **35:** 275–333. 1954; **36:** 52–109. 1955.

Kobuski, C. E. A revised glossary of the more common botanical and horticultural terms. Arnoldia **15:** 25–44. 1955.

Merrill, Elmer Drew. The botany of Cook's voyages and its unexpected significance in relation to anthropology, biogeography and history. Chron. Bot. **14:** 163–384. *pl. 89–92.* 1954.

Sax, Karl. The control of tree growth by phloem blocks. Jour. Arnold Arb. **35:** 251–258. *pl. 1.* 1954.

——— Dwarf trees with bark inversion. American Fruit Grower **75**[3]: 38, 39. 1955.

——— The effect of ionizing radiation on plant growth. Amer. Jour. Bot. **42:** 360–364. 1955.

——— Here's easy way to dwarf trees. Better Fruit **49:** 9, 10. 1954.

——— Population problems of Central America. Ceiba **4:** 153–164. 1954.

——— Plant breeding at the Arnold Arboretum. Arnoldia **15:** 5–12. 1955.

——— Stock and scion relationship in graft incompatibility. Proc. Amer. Soc. Hort. Sci. **64:** 156–158. 1954.

——— & A. G. Johnson. Induction of early flowering of ornamental apple trees. Jour. Arnold Arb. **36:** 110–114. 1955.

——— & E. D. King. An X-ray analysis of chromosome duplication. Proc. Nat. Acad. Sci. **41:** 150–155. 1955.

———, E. D. King & H. Luippold. The effect of fractionated X-ray dosage on the frequency of chromatid and chromosome aberrations. Radiation Research **2:** 171–179. 1955.

Schwarten, Lazella. Index to American Botanical Literature. Bull. Torrey Bot. Club **81:** 371–385, 473–487, 519–532. 1954; **82:** 70–85, 141–154, 253–260. 1955.

Wood, Carroll E. Evidence for the hybrid origin of Drosera anglica. Rhodora **57:** 106–130. 1955.

Wyman, Donald, *editor*. The Arnold Arboretum Garden Book. New York, D. Van Nostrand Co., 1–354. *illust.* 1954.

——— The Arboretum lilacs in their order of bloom. Arnoldia **15:** 17–23. 1955.

——— Choice plants to please nurserymen & homeowners. Am. Nurseryman **100**[11]: 11–12, 67–69. 1954.

——— Fifty better ground covers. Plants & Gardens **10:** 290, 291. 1954.

——— Forcing hardy woody plants in the greenhouse for early bloom. Arnoldia **15:** 1–4. 1955.

——— How to fall-plant trees & shrubs. Popular Gardening **5:** 32–37. 1954.

——— Hurricane Carol in the Arnold Arboretum. Arnoldia **14:** 37–40. 1954.

——— Maples for park and garden use as they grow in the Arnold Arboretum. Arb. Bull. **17:** 113–115, 130. 1954.

——— Plant for permanence — American Holly. Flower Grower **41:** 54, 55. 1954.

——— Plant for permanence — Virginia Rose. Flower Grower **41:** 16, 17. 1954.

——— Rehabilitation of trees injured by hurricanes of 1954. Arnoldia **14:** 41–55. 1954.

——— Some old fashioned roses at the Arnold Arboretum. Arnoldia **14**: 29–32. 1954.

——— Spring comes to the arboretum. Arnoldia **15**: 13–16. 1955.

WYMAN, DONALD. Trees and shrubs for the new garden. Popular Gardening **6**: 34, 35. 1955.

——— Wilfrid Wheeler — The hollyman. Arnoldia **14**: 65–72. 1954.

RICHARD A. HOWARD,
*Director.*

## Staff of the Arnold Arboretum
### 1954–1955

Richard Alden Howard, Ph.D., Arnold Professor of Botany, Professor of Dendrology, and Director.

---

Joseph Horace Faull, Ph.D., Professor of Forest Pathology, Emeritus.

Elmer Drew Merrill, S.D., LL.D., Arnold Professor of Botany, Emeritus.

---

Irving Widmer Bailey, S.D., Professor of Plant Anatomy.

Roger Gibbs Coggeshall, Propagator.

Michael Anthony Conoso, M.S., Custodian of the Herbarium.

Beatrix Farrand, L.H.D., Consulting Landscape Gardener.

Alfred James Fordham, Assistant Superintendent.

Heman Arthur Howard, Assistant Horticulturist.

Shiu-ying Hu, Ph.D., Botanist, Flora of China Project.

Ivan Murray Johnston, Ph.D., Associate Professor of Botany.

Clarence Emmeren Kobuski, Ph.D., Curator.

Su-ying Liu, Ph.D., Botanist, Flora of China Project.

Susan Delano McKelvey, A.B., Research Associate.

Yvonne Lieben Meigs, D.Sc., Assistant Librarian.

Lily May Perry, Ph.D., Botanist.

Karl Sax, S.D., Professor of Botany.

Lazella Schwarten, Librarian.

Yu-Chen Ting, Ph.D., Botanist, Flora of China Project.

Frans Verdoorn, Ph.D., Research Associate.

Ethel Elizabeth Upham, A.B., Herbarium Assistant.

Stella M. Whitehouse, Business Secretary.

Robert Gerow Williams, B.S., Superintendent.

Carroll E. Wood, Jr., Ph.D., Associate Curator.

Donald Wyman, Ph.D., Horticulturist.

# INDEX

# PUBLICATIONS FOR SALE AT THE ARNOLD ARBORETUM OF HARVARD UNIVERSITY CAMBRIDGE, MASS.

**JOURNAL OF THE ARNOLD ARBORETUM.** Published quarterly by the Arnold Arboretum of Harvard University. Subscription price $7.00 per year.

Vols. I–XI out of print. Vols. XII (1931), XIII (1932): *Price* $3.00 each. Vols. XIV (1933)–XXVI (1945): *Price* $4.00 each. *Note*: Vol. XXVII (1946) number four is out of print; price of nos. 1, 2 and 3 is $2.00. Vol XXVIII (1947): *Price* $4.00. Vols. XXIX (1948)–XXXVI (1955): *Price* $7.00 each.

A limited number of Vol. XXXVI nos. 2 and 3 (the number dedicated to Dr. I. W. Bailey). *Price* $5.00.

**ARNOLDIA;** a continuation of the Bulletin of Popular Information of the Arnold Arboretum. About 12 numbers per year. Subscription price $2.00. Price of single numbers $0.25 each.

**THE BRADLEY BIBLIOGRAPHY.** A guide to the literature of woody plants, including books and articles in the proceedings of learned societies and in scientific and popular journals, published in all languages, to the end of the nineteenth century. Compiled under the direction of Charles Sprague Sargent by ALFRED REHDER. 4°. 5 vols. Cambridge, 1911–1918. Unbound *Price* $30.00

**THROUGH THE ARNOLD ARBORETUM.** A guidebook, 44 pp., map, and 19 illustrations, four in color, 1949. *Price* $0.50

**YUCCAS OF THE SOUTHWESTERN UNITED STATES.** By SUSAN DELANO MCKELVEY.

Pt. I. Out of print.

Pt. II. 192 pp., 8 maps, 65 plates, 4°. Jamaica Plain, Mass., 1947. *Price*, $10.00

**BIBLIOGRAPHY OF CULTIVATED TREES AND SHRUBS HARDY IN THE COOLER TEMPERATE REGIONS OF THE NORTHERN HEMISPHERE.** By ALFRED REHDER. xl + 825 pp. 4°. Cambridge, Mass., 1949. *Price* $20.00

**INDEX RAFINESQUIANUS.** The plant names published by C. F. Rafinesque with reductions, and a consideration of his methods, objectives, and attainments. By ELMER D. MERRILL. vi + 296 pp. 4°. Baltimore, Md., 1949. *Price* $10.00

## CONTRIBUTIONS FROM THE ARNOLD ARBORETUM

1. DARKER, G. D. **The Hypodermataceae of Conifers.** 131 pp. 27 pl. 1932 $3.00
2. FAULL, J. H. **Taxonomy and Geographical Distribution of the Genns Milesia.** 138 pp. 2 figs. and 9 pl. 1932 ..... $3.00
3. JOHNSTON, I. M. **Studies in the Boraginaceae, IX.** 102 pp. 1932 .... $2.00
4. WHITE, C. T. **Ligneous Plants Collected in North Queensland for the Arnold Arboretum by S. F. Kajewski in 1929.** 113 pp. 9 pl. 1932 ..... $2.75
5. STANDLEY, P. C. **Flora of Barro Colorado Island, Panama.** 178 pp. 21 pl. and map. 1933 ..... $3.50
6. RAUP, H. M. **Phytogeographic Studies in the Peace and Upper Liard River Regions, Canada. With a Catalogue of the Vascular Plants.** 230 pp. 9 pl. and map. 1934 ..... $2.50
7. EHRLICH, J. **The Beech Bark Disease; a Nectria Disease of Fagus following Cryptococcus Fagi (Baer).** 104 pp. 9 pl. 1934 ..... $2.00
8. MERRILL, E. D. **An Enumeration of Plants Collected in Sumatra by W. N. and C. M. Bangham.** 178 pp. 14 pl. 1934 ..... $2.50
9. Out of print.
10. CRAEGER, D. B. **The Cephalosporium Disease of Elms.** 91 pp. 16 pl. 1937 ..... $2.00
11. FAULL, J. H. **Taxonomy and Geographical Distribution of the Genus Uredinopsis.** 120 pp. 6 pl. 1938 ..... $2.00

## SARGENTIA: a continuation of the Contributions

(issued at irregular intervals)

1. SMITH, A. C. (and COLLABORATORS). **Fijian Plant Studies, II.** 148 pp. 5 figs. 1942 ..... $2.50
2. LI, H. L. **The Araliaceae of China.** 134 pp. 14 figs. 1942 ..... $2.25
3. CHEN, L. **A Revision of the Genus Sabia Colebrooke,** 9 figs.; and MERRILL, E. D. & L. CHEN. **The Chinese and Indo-Chinese Species of Ormosia.** 120 pp. 1943 ..... $2.00
4. PORSILD, A. E. **Materials for a Flora of the Continental Northwest Territories of Canada;** and RAUP, H. M. **The Willows of the Hudson Bay Region and the Labrador Peninsula.** 135 pp. 4 pl. 1943 ..... $2.50
5. LAM, H. J. **Fragmenta Papuana [Observations of a Naturalist in Netherlands New Guinea].** (translated from the Dutch by L. M. PERRY). 196 pp. 2 maps and 32 figs. 1945 ..... $3.00
6. RAUP, H. M. **The Botany of Southwestern Mackenzie.** 275 pp. 37 pl. and 16 figs. 1947 ..... $5.00
7. SMITH, A. C. **The Families Illiciaceae and Schisandraceae.** 224 pp. 41 figs. 1947 ..... $4.50
8. JOHNSTON, I. M. **The Botany of San Jose Island** (Gulf of Panama). 306 pp. 17 pl. and 2 figs. 1949 ..... $6.00

---

All correspondence pertaining to publications should be addressed to the Librarian. Make checks payable to the ARNOLD ARBORETUM, 22 Divinity Ave., Cambridge 38, Mass.